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REGULATION OF ACCUMULATORS.

WHEN asked what method of "automatic regulation" he considered the most reliable, Mr. Edison replied, "A live negro in charge of the regulating switch." The word "live" was doubtless introduced as a saving clause against the possible association of an automaton nigger with the idea of an electric circuit. Mr. Edison has been credited with many pithy sayings; he never contradicts them, and since we have the quotation from a gentleman who has recently arrived from the States we have ventured to reproduce it in connection with this important subject. Many methods of automatic regulation and distribution have been devised from time to time, and some have been put into practice. The most noteworthy of these is probably that of Mr. F. King, which was tried in its crude form at Colchester in the year 1884, and recently in its more elaborated character at Chelsea. Complex as this apparatus may appear from the description given by Major-General Webber at the last meeting of the British Association, we learn that up to the present it has been working most satisfactorily. Mr. Henry Edmunds's system we had an opportunity of seeing at the time when his paper was read before the then Society of Telegraph Engineers and Electricians, but we have no recent information as to its continued working. Sir David Salomons again has been elaborating a method of automatic regulation with his well-known accumulator plant at Tunbridge Wells, which is ingenious, but complicated. Mr. R. E. Crompton's scheme of distribution and regulation, although not quite automatic, is nearly so, and gives excellent results at the Kensington and Knightsbridge central station; it has the merit of extreme simplicity, but requires some hand-regulation. Which of the above systems will bear away the palm for perfection, safety, reasonable cost, and efficiency, time alone can tell; meanwhile we have the satisfaction of knowing that substantial progress is being made in this branch of the electrical industry, and we hail with pleasure the substance of an interesting paper from the pen of Mr. G. B. Prescott, jun., of New York, as read before the American Institute of Electrical Engineers. Mr. Prescott advances little that may be called new, but he develops the subject of accumulator regulation in a manner which merits the attention of every student as well as the interest of experts, and we have thought it of sufficient value to reprint the entire paper, a portion of which appears in this week's issue. We agree with the author when he says: "Every careful observer will acknowledge that, even as it exists to-day, the accumulator is a factor in electrical industry too important to be ignored by those who take a broad view of the situation," and we have often pointed out that the success or failure of storage batteries is in a large measure due to the methods of treatment; therefore, if an absolutely perfect automatic regulation can be devised and adapted to the nature of the cells, there will be no more trouble beyond the inherent defects due to the more or less healthy constitution of different types of plates. The greatest virtue which can be and is advanced in favour of accumulator distribution lies in the fact that the power plant can be used all day at its full capacity. Mr. Prescott cites an example, and notes that "if the dynamo is started at 8 a.m., and operated until 6 p.m., while maintaining the required number of lamps during that period it will still have a surplus current for charging the battery to 890 ampére-hours, an available capacity vastly in excess of requirements." But he can only charge the cells of his example at the rate of 30 ampéres, consequently he only utilises about one quarter of the available energy. If he wishes to charge at the rate which the dynamo can give in excess of the lamps requirements, he would want a battery of four times the size suggested, because the life of his cells depends upon the current rate. This would mean four times the cost in accumulators; he cannot afford so much extra expense, and prefers to lose the chance of storing up the available balance of 650 ampére-hours, equal to one-half of the entire output of his plant. This points to a weakness. It shows that the cells should be made not to have a greater capacity, but to receive and give current at a more rapid rate. In all storage batteries the normal discharge rate is proportional to the surfaces of the plates, and with the pasted types of plates a certain thickness has been found to give the best results both as regards capacity and durability, and certain defined limits have been reached. To go beyond these limits, even to a slight extent, means buckling, paste dropping, or generally shortening the life of the plates. Experience teaches, and the price lists of the best makers show, that a fully charged cell should not be discharged in less than 10 hours, or at a maximum working rate equal to one-tenth the capacity in ampère-hours. Practice demands a maximum current for two, or at most three, hours per day; therefore, an ideal accumulator would be one which should, if required, discharge in about four hours without detriment to its durability, and without material changes in its electromotive force. We believe that such a battery will be forthcoming at an early date, as we hear of successful experimental results having been obtained from plates which have no oxide paste, but the surfaces of which are oxidised in a few hours by an entirely new process. Such an accumulator will have the effect of simplifying regulating devices, and of materially cheapening the cost and maintenance of central lighting stations.

ENGLISH *versus* AMERICAN PRACTICE.

THE remarks made by Mr. Addenbrooke at the American Institute of Electrical Engineers, and which we publish elsewhere in our pages, are in many respects deserving of notice, as they are the remarks of a man who has had practical experience in matters which are seldom spoken about. The major portion of what was said referred to the construction of overhead lines, details being given of all points relating to the same. One fact seems to stand out prominently and that is, that in America the work is done far more cheaply than is the case in this country; we do not mean cheap in the sense of "cheap and nasty," but it would appear that work which from its unsightliness would not be tolerated here, is apparently looked upon over the water with indifference. Not but that there is plenty of room for improvement in this country from the point of view of sightly lines, but at least some attempt is made to keep things shapely and trim, though this involves cost. It would have been interesting if Mr. Addenbrooke had mentioned how matters are managed as regards indoor fittings. Much of the success of the covered wire systems in this country is, no doubt, due to the very large experience which has been had in insulated wire in the shape of submarine cables; the immeasurable importance of what almost amounts to total absence of defects in the case of submarine cable cores, has rendered skilful manufacture and sound quality a rule-of-thumb business, and has also reduced what may appear to be somewhat complicated tests, to an integral part of the daily work of a cable factory. The consequence of this is that all classes of work are thoroughly overhauled before the finished material leaves the factories, and with great benefit to the purchasers and users.

Speaking of electrical tramways, Mr. Addenbrooke has, we think, most decidedly overdrawn the bow in endeavouring to make out that we in this country are not after all so far in arrears in this branch of electrical engineering. To compare the few miles of insignificant lines, which can be counted on the fingers of one hand, with the mileage in actual operation in America is, we think, quite absurd. No doubt, one great reason why we are so behindhand here, is the fact that the use of overhead wires for tramway purposes in city streets would not be entertained for a moment by the municipal authorities, and it is this system which appears to be almost universally used in the States.

Mr. Addenbrooke's reference to alternating currents were of value, but his opinion that there is nothing to prove that an insulated wire will break down sooner by an alternating current than by a continuous one is startling, seeing that the use of alternations to break down minute faults in insulated wires is of constant occurrence in cable factories. We are somewhat surprised at the remarks of the chairman which called forth the reference, viz., that "It is absolutely impossible by any known means of insulation to insulate an alternating current of 1,000 volts." Everything depends upon the good manufacture of the cables and the careful handling of the same. Given good workmen and skilled foremen to look after them, sound underground cable work which will stand such high potential alternating currents should present no difficulties in carrying out.

In referring to the Grosvenor Gallery installation, the speaker stated that a good deal of the proper regulation of the lights was due to the arrangement of the circuits, so that the extinction of a large number of lamps on one particular circuit never took place; a judicious grouping of the lamps on various circuits is, we think, a point of vast importance, and is of more value than all the automatic appliances that have been or are likely to be invented for the purpose of preventing fluctuations.

ALL things come to him who waits is a very old proverb, but there is also another which is equally true and that is, he who waits longest gets nothing. Both these are true in regard to *Industries* motor competition. A few weeks ago our office boy, who seems to possess a wonderful prophetic vision, foretold that the award would be made known this year. The announcement to this effect was made by *Industries* in its last issue, and our office boy, whom we are now promoting to a higher duty, makes another prophecy, namely, that *Industries* will *never* again open similar competitions, notwithstanding the announcement made in that journal over three years ago to the effect that such competitions would be held occasionally.

WHEN are the necessary steps to be taken in order to put a stop to electric quackery as now carried on in different quarters? We have frequently drawn attention to the imposition which is being practised by certain individuals and we have once more to protest against the use of the word electricity where it does not apply. The present case is to be found in the advertisement pages of *Commercial Ireland*, where a Belfast individual advertises his "world renowned electric remedies." Two of these are "electric ointment and wonderful electric powder." Strange to say in the same issue of that journal is a well written description of the electric tramcar trials at Birmingham, and yet an advertisement of the kind in question is allowed to appear, notwithstanding that under its old and also under its present title our contemporary laid some claim to technical knowledge. We should advise the Belfast advertiser to get some real electric ointment by taking hold of a fairly "live" electric wire.

BUT brazen effrontery must pay. The purveyors of electropathic belts not only gull the people by their displayed advertisements, but they seem to have imbued a portion of the weekly press with a belief in the efficacy of their wares. As an instance, a weekly paper, having an immense circulation among private households, advises a correspondent to try one of the belts, and adds, "do not think that such belts are purveyed by mere quacks, for they are singularly useful." This, as a means of filling the pockets of their manufacturers ought to have been appended, but was not. It would be interesting if one of the dupes were to bring an action against the vendor for selling goods under false pretences.

WITH regard to the warfare of words now waging between Mr. S. A. Varley and others, we have gathered together a few items of information which may, perhaps, modify the opinions of that gentleman. At the Central Institution the four professors, Messrs. Ayrton, Unwin, Armstrong and Henrici, receive salaries of a stated sum per annum (they derive nothing additional from fees), and they are under engagement not to undertake professional practice outside. At Finsbury there are also four professors (the principal, Dr. Silvanus Thompson, and Professors Perry, Meldola and Brophy [Art Department]). With the exception of the principal these are not restricted, otherwise than by the time utilised in their duties, from taking up professional work outside. Naturally in cases where a professor is retained previous to entering upon new engagements, he is allowed to see such matters through.

A MAN in New York who was knocked senseless a few weeks back by an electric wire, and who has since become a confirmed paralytic, has instituted a suit against the United States Illuminating Company to recover $50,000 damages. Should the action be successful, and the company be mulcted in heavy damages, more will have been done to secure the public safety than all the efforts of the authorities have achieved in the past, or seem likely to achieve for years to come.

THE injunctions obtained a short time back by the United States and Brush Illuminating Companies to prevent the City authorities from summarily tearing down their wires, has been continued by the Supreme Court, which has decided that the electric light companies have the right to maintain their wires overhead until the subways are completed, and fixed the responsibility for the failure to complete the subways on the Subway Company, but the duty of keeping the wires properly insulated devolves on the plaintiffs, and that permission to repair old wires and replace them with new and safe wires should be obtained from the Board of Electrical Control, by mandamus if necessary. The Board of Electrical Control has the right to require the companies to discontinue the use of dangerous wires, but has not the power to compel the removal of same; this the Commissioners of Public Works can do after notice to the companies and giving a reasonable interval to enable the companies to put their lines into working order. This decision is viewed in different lights by the opposite parties. Expert Wheeler thinks that the companies will still have trouble to run their circuits, as he knows already of some 5,000 defects in them, and that the lighting operations will be very limited for some time to come. On the other hand, the Brush Company is elated that it can continue its overhead service, and explains the situation, as to putting its wires underground, by relating the story of Pat and his Irish bees: "In recounting the wonders of Ireland, he declared that the honeybees were as big as sheep." A little later on, someone asked him casually how big the hives were in Ireland, and he admitted they were of the usual size. "Then how could the bees get in?" Pats's reply was, "Sure, that's their own look out." The Brush Company would see to that when the hives were ready.

LAST week we called attention to the meeting of the National Electric Light Association's Executive Committee, and the resolutions adopted with regard to high tension currents. Without doubt the opinion that they are, in the States, essential for the successful and economical distribution of electricity, is perfectly correct, for a variety of reasons which need not be stated here, Mr. Edison to the contrary notwithstanding. But are the currents which the "Wizard of Menlo Park" characterises as unnecessary as they are dangerous, equally valuable in England? Here we make no use, even if we had the opportunities, of water power, on anything like a practical scale for economy in long distance transmission; fuel and gas are cheap; we have no new towns springing up with mushroom-like growth, and all parts of our little island are more or less in touch. With conditions, then, so essentially different to American requirements, it is a question whether the employment of high tension alternating currents is generally desirable, and the Institution of Electrical Engineers might do worse than to promote a lively discussion on this point. Some member should be prevailed upon to send in a paper dealing with the subject from American and English standpoints, and we feel sure that the result of the arguments *pro* and *con* would lead to definite views being formed.

WE are glad to publish the letter from Mr. Von Buch. Mr. Bebro made a statement in Court without any corroborative evidence whatever, and this Mr. Von Buch was unable to deny, not being put into the witness box. His explanation of the circumstances which led to his name being dragged into a very discreditable case will doubtless be deemed eminently satisfactory, and we are pleased to be the means of bringing to light the true facts of the case.

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

YOU have mentioned an interesting installation which is to be erected near Wiener-Neustadt with alternating current transformers for the simultaneous production of power and light. I can now inform you that this installation, which was projected by the Wiener-Neustadt Brewery in order to utilise its superfluous water-power, is already completed, and that it was a few days ago set in successful action.

The generator is a Zipernowsky alternating current machine of the type A_5, which at 500 rotations per minute gives a primary current of 25 ampères and 2,000 volts. Of this energy about 12,000 watts are converted by transformers into a current of 100 volts tension, and used for feeding glow lamps, whilst the remaining energy is used for the production of motive power—amongst other things, for setting in motion various machines used in the brewery. To this end, three alternating current motors have been set up, two of which, with a speed of 830 rotations per minute, furnish each 10 horse-power, whilst the third revolves 1,250 times per minute and gives off 5 horse-power. The distance between the generator and the furthest motor is about 3,000 metres.

The impulse to the construction of this installation was given by an eminent technical electrician, Herr Max von Berndt, who is both a shareholder in the Wiener-Neustadt Brewery and owner of the manufactory of glow lamps at Wiener-Neustadt, and who has taken an active part in carrying out the requisite works, as he conducted the fitting up the lamps and set them in action. The installation here described is the first in which alternating current motors are at work. Herr Max von Berndt may therefore claim the honour of having inaugurated the practical application of alternating current motors.

The London Brush Company has again felt itself induced by the continually increasing demand for the electric light at Temesvar to extend the installation of transformers which it put up last year for supplying the electric light to private consumers. For this purpose it has ordered at Buda-Pest a third alternating current machine of the type, W_5, for 80,000 watts.

The Berlin "General Electrical Company" purposes, in conjunction with the Aluminium Industries Company, to erect in Austria a large establishment for producing aluminium and its alloys, and it has secured for this purpose, at Lenal (Salzburg), a water power of several thousand H.P.

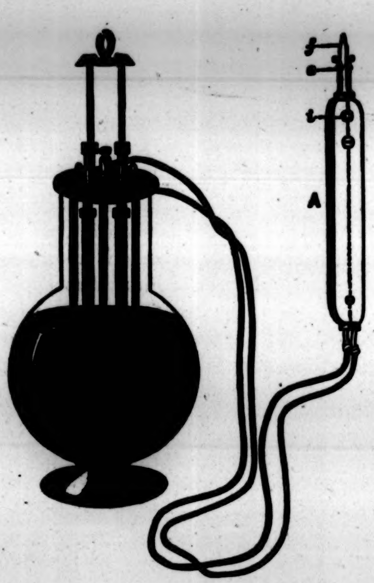
Herr Zipernowsky delivered to-day (November 9th), at Buda-Pest, a lecture on his newly invented tramline with a vertical track, which was very numerously attended, especially by the members of the Hungarian Association of Engineers and Architects, and by many representatives of science and industry. Herr Zipernowsky displayed for the first time this system to the public, having, for this purpose, put up a model line at the works of Ganz & Co., with two points and a small car, upon which was placed a minature electromotor, and caused it to work during the lecture. The minature tramcar, driven by the electric current, worked very well, and the automatic points acted with astonishing precision. The audience had the opportunity of becoming convinced that this interesting system actually possesses those advantages which were expected.

Herr Wangemann, who, during his stay in Vienna, had the honour of exhibiting Edison's phonograph to the Emperor Francis Joseph, is about to make a two days' stay in Buda-Pest, where he has been invited by the Board of the Buda-Pest Telephone Company, in order to give their subscribers a pleasant surprise. Everyone received a free ticket to the demonstration of the phonograph. Herr Wangemann—as he had done in Vienna—will give in Buda-Pest public demonstrations, but he has not yet fixed on the exact time.

A NEW SIMPLE AND ECONOMIC GALVANO-CAUTERY.*

By DR. ARMAGNAC.

IN a former sitting, after a communication from one of our colleagues, the question of the employment of the galvano-cautery in surgery for the operation of tracheotomy arose incidentally, and reference was made to the numerous inconveniences of the various models in use at present; the more or less considerable bulk of the batteries, the irregularity of their working, the more or less complicated management of them, their high price, the size of the handles and conducting wires, their inconvenient form, &c. I then promised to bring before you a model which seems to me exempt from all these inconveniences, and which is shown in the accompanying figure. I have used it for ocular cases for several years, and I can assure you that its working is as simple as convenient. Its construction is so little complicated that each of you might manufacture one for yourself, as I myself manufactured the one I am now presenting to you. It only cost me 12 francs—a consideration of some importance.



As you see, I had no need to go to much expense in constructing the battery. I simply took an ordinary Grenet battery (bottle type) of two litres, with two zincs, and I connected, by a cross-piece of copper furnished with a ring, the rods supporting the two zincs, so as to be able to plunge them simultaneously into the solution of bichromate of soda or potash contained in the bottle. This arrangement enables us to obtain the whole effect of the battery from the minimum to the maximum of power, by simply lowering the zincs more or less. If we wish to heat to red heat a very fine strip of platinum, we have merely to plunge the zincs into the exciting liquid to the depth of one or two centimetres; by completely submerging them we may easily heat to red heat over one centimetre of its extent a wire two-thirds of a millimetre in diameter.

So much for the battery. We will now examine the handle that holds the cauteries. You know that in the various models of galvano-cauteries of commerce, each knife, or slip of platinum, is mounted upon a support which itself fixes upon the handle. Thus as many of these accessories are required as there are cauteries used, and however varied these may be the surgeon may, unexpectedly, require a special arrangement adapted to a particular case; he is then at the mercy of the manufacturer, who is not always within reach or at his disposal.

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* Communicated to the Society of Medicine and Surgery at Bordeaux, at the sitting of May 3rd, 1889.

With the holder that I have the honour to submit to you, there is no need of manufacturers of cauteries. With platinum wire of different thicknesses, a pair of pincers and a hammer, the surgeon can in a few seconds improvise cauteries of infinite forms, fixing firmly and conveniently on the same handle. He thus gains not only in economy, each cautery costing merely a few centimes or a few sous, but he is also rendered independent of the manufacturer, since he can modify his cauteries at will according to his requirements.

The holder that I have manufactured myself, for my own use, has one little inconvenience, it has no interrupter of the current, so that it does not enable one to heat the slip of platinum or the knife at the exact moment required. This is sometimes of grave importance. With children, for instance, the red-hot platinum is a source of terror, and not without cause, if the cautery is to be applied to the eye. Moreover, with a holder that works constantly with a closed current, the surgeon is not able to moderate or intensify the incandescence of the cautery, and we all know, that according to the circumstances of the case, we prefer sometimes dull red, sometimes glowing red, and sometimes white heat. A holder furnished with an interrupter is therefore necessary in order to profit by all the advantages that my instrument is capable of offering.

For several years not wishing to make my galvano cautery known until I could also say where it could be procured well made, I applied in vain to many constructors without being able to find one that would put my idea into a satisfactory industrial form. At last I found at Bordeaux two gentlemen who volunteered to supply my wants: M. Mouroux, optician, who undertook to furnish me with the bottle battery, coupling the zincs, and M. Gendron, who, under my instructions, manufactured a very convenient little holder with an interrupter. Either of these makers will, henceforward, be able to supply the apparatus complete. The holder, A, is very slender and very light; it is held in the hand as easily as a knife or pen-holder. It consists of two plates of ebony, connected together by ferrules or screws, and enclosing two large copper wires, one of which is continuous and the other arranged for interrupting the current by means of a button, *i*, placed outside. These wires pass through the bottom of the handle into conductors terminated by a cylinder. At the upper part they are hollowed out on their inner surface into a groove, ending at each of the extremities, and in these are placed the platinum wires, *f*. The latter, whatever may be their thickness, are fixed easily and firmly into the required position, by means of a simple sliding ring, *c*.

The formula of the exciting liquid of the battery is as follows:—

Water	2,000	grammes.
Bichromate of potash or soda ...	250	„
Sulphuric acid	300	„
Hydrochloric acid...	200	„

The ordinary Grenet battery of commerce certainly leaves much to be desired as regards construction, nevertheless it can be utilised as it is. The incandescence of the platinum wire does not last long, a few minutes only; but by raising the zincs from time to time we may produce a series of incandescences, the total duration of which exceeds several hours.

In submitting my model to you, I do not expect it to take the place of the various models in use, some of which are excellent and very powerful. I merely wish to show the advantage of using a battery that can be obtained anywhere, and which has the additional recommendation of only costing 12 francs. I beg also to call special attention to my cautery-holder, which constitutes the original part of my apparatus, since it enables anyone to make for himself his platinum slips or knives, and it can be employed with all the batteries at present in use for galvano-cauterising.

Up to now I have only used my apparatus for slight optical cases; but its application might certainly be greatly extended, for a slip of thick platinum wire ⅔ of a millimetre in diameter is sufficiently resistant to make a deep puncture or an incision, and it could, if required, burn through a thin board.

THE FRENCH TELEPHONES.

In the Electrical Review of November 1st we published the text of two decrees which had appeared in the *Journal Officiel* as to the new regulations for working the telephones since their acquisition by the State. To each of these decrees was appended a report, the substance of which we reproduce below. The first of them runs as follows:—

Monsieur le Président,—I have the honour to submit to you a form of decree which has for its object the fixing the price of telephonic conversations on the urban and interurban lines, when they are not subject to the subscription *régime*. A decree of December 31st, 1884, fixed at 50 c. in Paris, and at 25 c. in all other localities, the amount to be collected on entering a public telephonic cabin for 5 minutes' conversation with an urban line. The same decree fixed at 1 f. the sum to be collected for five minutes' conversation from town to town for every distance less than 100 kilometres. This decree was applied in January, 1885, to the line from Rouen to Havre, which is less than 100 kilometres; but the general prescriptions which it enacted have been lost sight of since then: for special decrees fixed at 1 f. the sum on communications between Paris and Reims, Paris and Havre, Paris and Rouen, and Paris and Lille, which are all more than 100 kilometres. In addition, by a decree dated December 28th, 1886, in connection with an international convention, the amount payable on communications exchanged by the Paris-Brussels line (340 kilometres), was fixed at 3 f., and a decree dated July 28th, 1888, fixed at 2 f. the amount payable on communications between Paris and Lyons (531 kilometres), and at 3 f. for those between Paris and Marseilles (888 kilometres). It is certain that there is no sort of correlation between these various amounts, and that they repose on no rational basis. Experience has demonstrated that the construction of an interurban telephone line requires the employment of a wire, the diameter of which must increase at the same time as its length. No scientific law yet permits of establishing in a rigorous manner the coefficient of this increase, but it produces, from a financial point of view, consequences of which an example will show the importance. Thus, granting the price of a copper line of 100 kilometres double wire is 35,000 f., a line of 800 kilometres, for example, constructed under conditions appropriate to its length, will cost, not eight times more, but at least 20 times more; that is to say, at least 700,000 f. The excessive expense entailed by the establishment of a long-distance telephone line must necessarily have an effect on the fixing of prices. Consequently a special Commission was charged to seek which was the method of fixing the prices best adapted to the interurban lines. Three systems were examined in succession:—1. A uniform tariff, whatever the expense and whatever the distance. 2. A tariff proportional to the expense. 3. A tariff proportional to the distance. A uniform payment is only admissible if it is not out of proportion with the smallest services which it is destined to remunerate, without, however, imposing on the State charges which might appear excessive. Now, in face of the considerable divergence which exists between the net price of long and short distance lines, it is impossible to find a telephonic price uniting all these conditions. In a word, if it is high enough to be remunerative, it will tax beyond all proportion short-distance communications; if it be low enough to facilitate those communications, besides entailing upon the Treasury a considerable loss, it will have for its effect the provoking of a number of demands for communications on the long-distance lines, which it will only be able to meet by constructing new lines, that is to say, to increase the deficit by new expenses which would be costly and unproductive. The tariff proportional to the expense presents results diametrically opposed. This would have for its consequence the raising of prices on the long-distance lines to the height of giving them a prohibitive character. The tariff proportional to the distance, which forms a sort of transaction between the two preceding systems, avoids their inconveniences, and, looked at as regards expense, it constitutes a tariff on a descending basis. I propose to you to adopt the principle. The system once admitted, there remains to be determined the elementary price which must serve as its basis. From some very complete comparative and statistical studies which have been made on the subject, it appears that a tariff of 50 c. per 100 kilometres or fraction of 100 kilometres is very moderate. As a consequence of its application, the price of conversations will be increased on some lines and decreased on others. In any case, if the length of our lines be taken into account, it will be very notably inferior to that which is collected on foreign interurban lines. It appears the more necessary not to adjourn the proposed reform as, the Administration of Posts and Telegraphs being at this moment engaged in studying the creation of new lines, and in view of their being put into working, it would be interesting to prepare from now a system of methodical charges. I am in favour of maintaining, in a general manner, the normal duration of the conversation, which is now five minutes, in addition, be it understood, to the time necessary for putting the correspondents into communication; but we must anticipate the time when the number of demands for communication will be such, at certain hours of the day, and on certain lines, that, in order to diminish the waiting of the public, it will become necessary to restrict to three minutes the duration of the conversation. That is why I propose to you to leave to the Minister the care of appreciating the circumstances under which this reduction must be prescribed. Article 1 of the form of decree fixes, besides, the amount to be collected on entering a public telephone cabin and the placing in communication with an urban line. This article is only a reproduction of a similar disposition inserted in the decree of December 31st, 1884, and which I have mentioned above; but, with an idea of simplification, I have thought it useful to introduce it in the form of decree, with a view of uniting in the same regulation all the dispositions concerning telephonic conversations which do not come under the subscription *régime*. If you wish, then, M. le Président, to approve these propositions, I beg you to sign the following form of decree. (This decree appeared, as above stated, on November 1st.)

The second report, which is signed by M. Tirard, President of the Council and Minister of Commerce, Industry, and the Colonies, is as follows:—

Monsieur le Président—One of the most useful applications of the telephone consists in telephonic transmission to a telegraph office of the text of a telegram intended to be sent by that office. Hitherto, that transmission has been effected gratuitously by the State lines; but the General Telephone Company had only authorised it on its lines on the payment of a bonus on the subscription of 50 f. Now that the State works directly all the urban lines it is not possible to allow this duality of system to continue, and it seems there is no other alternative than to make a free gift to the company's old subscribers, or else to subject all the State's subscribers to a bonus on the subscription. I propose to you to adopt in principle the first resolution, but yet tempering it by an exception. It relates to towns which have a subterranean line. Its object is to prevent crowding in places where the space reserved for the wires is limited by canalisation of which they must follow the route. Thanks to this precaution, I estimate that it is possible to extend gratuitous transmission of telegrams by the telephone. But if this means may render useful services in centres which possess a telegraph office, they become of capital importance for communes which are deprived of them. The form of decree which I have the honour to submit to you has precisely for its principal object the placing at their disposal this new process of communication by giving to the principles of legislation in force a new application. Since 1864 the Telegraph Administration rightly occupied in placing the telegraph lines within the reach of rural populations, while restricting as much as possible the expenses of management, has created a special category of telegraph offices under the names of "municipal offices." The line which unites the commune to the general line was to be established at the common expense of the State and the municipality, the office installed in premises belonging to the commune, or rented by it and managed by a person chosen by it. This system, which was the object of special regulation, was favourably received and definitively fixed by a decree dated February 11th, 1882, which settled the contributory part of the communes in the establishment at 100 f. per kilometre of new line constructed, and at 50 f. per kilometre of wire to be established on supports already in existence. Since that time, the number of municipal offices has increased without cessation. There were, in 1883, 3,608; to-day there are 4,971. Out of 2,871 principal towns, 2,842 possess a telegraph office, while there are only 29 without them. I propose to you the creation of municipal telephone lines, and to extend to them the dispositions of the aforesaid decree. This innovation will permit of municipalities making a saving on the expenses of installation of the office, because the net price of the telephone office is less than that of the telegraph office. Again, instead of seeking, in order to manage the office, a special agent understanding the manipulation of the telegraphic apparatus, it will be sufficient to charge with the transmission of telegrams, in the absence of a postal receiver, either the office-keeper or the secretary of the *mairie*, or any other person presenting suitable guarantees. When several municipal telephone lines shall be joined to the same telegraphic office, that office will become, by force of circumstances, a centre by which communication can be made with different localities hitherto deprived of means of rapid communication, and in each commune the telephone post itself will become a point of attachment for telephone lines of private interest radiating around it. It is therefore permissible to foresee the time when every person away from a rural place will be able to possess at little expense, in his own house, an apparatus which will connect him on to the local telephone line, and, by means of that line, with the general telegraph line. Without doubt, these different applications of telephony may not be immediate, but they appear to me to be, in the immediate future, the necessary consequence of the measure which I have the honour to submit for your approbation. But in order that these results may be more easily produced, it is necessary that the cantonal telephone line should be completely finished. That is why I propose to you not to grant the benefit of the new dispositions to the 29 chief places of cantons which, hitherto, have not made use of the facilities which were offered them, in order to assure themselves the possession of a telegraph office. It is necessary that telegrams telephoned by a line dependent on an urban line or by a municipal line should not be of an excessive length, for the telegraph or telephone agent has to answer numerous and repeated calls, and good working of the service requires that his time should not be absorbed by the transcription of despatches containing a much higher number of words than the average of telegraphic correspondence. It is for this purpose that the form of decree limits to 50 words the text of the telephoned telegram. If you wish to approve of these different dispositions, I shall be obliged to you for investing with your high sanction the form of decree herewith.

Electric Lighting at Hove.—The Hove Commissioners have given notice of an application for a provisional order for the supply of electricity within the district.

ELECTRICITY IN SOUTH YORKSHIRE.

THE popularity of electricity increases, and the demand for the electric light grows apace in unexpected and unlooked-for directions. In places where one would naturally expect gas and the products of coal to be more popular than anywhere else, the demand for the electric light is increasing rapidly, and it is being brought into use at a great rate, enquiry respecting it having been quickened of late in a marked manner. Halifax, Dewsbury, Bradford, Leeds, are, and have been, enquiring into and using the electric light, and now, at Barnsley, the very centre and heart of the South Yorkshire coal-field, enquiry is going on. The Corporation have given notice of their intention to apply for power to supply electricity, and the National Electric Supply Company, amongst whose principal shareholders are several wealthy local gentlemen, is also about to apply for power to supply light and power within the borough. Already several effective installations are working in the town and neighbourhood, and others are continually being introduced. Wentworth Castle, Stainbro', the residence of Mr. T. F. C. V. Wentworth, one of the wealthiest commoners of England, is brilliantly illuminated, some 500 incandescent lamps being used to light up the house. The Co-operative Society's huge flour mills, warehouses, bakeries, shambles, are all lit by electricity, at a saving of about 60 per cent. as compared with gas. Within the past fortnight a large foundry, and last week the principal boiler works of the town, have successfully adopted the same means of lighting, and other firms are considering the question, several being spoken of as likely to adopt it in the early future. The cause of the present ferment on the subject is not far to seek. The directors of the local gas company have raised the price of gas 4d. a thousand feet, from 3s. to 3s. 4d. per 1,000 feet. The shareholders, timid at first, have been emboldened by the assurances of their chairman, who defies electricity to compete with gas, says it is a failure as a commercial speculation, and that it only succeeds in America because gas is from 6s. to 10s. per 1,000 feet, and have approved the advance. They will fight the electric light, they say, and beat it on its own ground. It is very probable that their challenge will be taken. The proposals of the Corporation are looked on with favour; so, too, are those of the National Electric Supply Company, and the latter, perhaps, gives the clearest idea of the reality of the feeling of the district in the matter, for chief amongst its subscribers are Mr. T. F. C. V. Wentworth, of Wentworth Castle; his son, Mr. Bruce C. V. Wentworth, Conservative candidate for the Barnsley Division; Mr. Dan Rylands, a successful and wealthy manufacturer, of the district; and Mr. C. H. Cobbold, well known as holding a large stake in several successful local companies. The gas company try to create a prejudice against the electric light by pointing to losses made in Leeds, Bradford, and elsewhere, and by fearsome pictures of men slowly roasting on the light wires they have been sent to repair, but their efforts do not carry much weight, and it is very probable that Barnsley, with gas coal collieries surrounding it on every hand, will be one of the earliest Yorkshire towns to effectively introduce the electric light.

ELECTRICAL CAPSTANS.*

By MAX DE NANSOUTY.

THE necessity of accomplishing quickly, and without undue expenditure of power, the loading and unloading of merchandise in ports, warehouses and large railway stations, has led our engineers to make remarkable improvements in the mechanical means of transporting energy to a distance.

As a general rule, force or energy is transmitted by gas, teledynamic cables, compressed or rarefied air, steam, hydraulic pressure or electricity. Each of these agents is suited by its nature to certain special cases into which we cannot enter now. As regards harbours, warehouses and railway stations, two of these agencies are specially adapted to this purpose, and their suitability has been established by very interesting practical experiments—these are hydraulics and electricity.

In 1880, the Northern Railway Company, at Paris, in their important goods stations at La Chapelle, showed the advantages that could be derived from hydraulic pressure for working capstans and taking the place of horses for the traction of waggons and for their rotation with locomotives upon turn-tables. Since that time we have had occasion to describe in *La Nature* the very interesting hydraulic installation made by the Western Company at the station of St. Lazare, in Paris, upon the plan adopted in the greater number of our large sea ports. We must remember that to Armstrong belongs the credit of having established the first hydraulic lifts as used at the present day, and of having adapted the application of hydraulic pressure to the distribution of motive power for domestic use: in 1853 he worked printing motors at Newcastle by employing the water of the town. Similar installations were made subsequently at Hull and in London; capstans, cranes and windlasses in each case serving as the mechanical agents.

Hydraulic pressure is an excellent agent, but it has certain drawbacks which engineers are continually endeavouring to remedy; deposits in the pipes, losses of charge and escapes, the high pressure to be given to the liquid, difficulties and expenses of installation at the central works where the force is produced, and lastly, the necessity of having boilers and motors always at work to effect operations of short duration.

Thus it was natural that engineers should turn their attention to the new agent for the production and the transport of energy, viz., electricity. This is what has just been done by M. A. Sartiaux, the eminent engineer-in-chief to the Northern Company, with the assistance of M. Eug. Sartiaux, the head of the telegraphic department of the same company. The Society for the Transmission of Force by Electricity at the same time volunteered to attempt, with the help of the staff of the engineers of the Northern Company, the practical realisation of this new and delicate problem.

The principal advantages of electricity for the transmission of energy are well known, the most important being the dispensing with the use of conduits, with the return or escape by leakages of the fluids used, according to whether these fluids are rarified or compressed in these conduits. We also know that, having at our disposal the principle of reversibility of electrical machines, it is possible to impart a rotatory movement to an electrical machine at a great distance by sending into it, by an electric conductor, the current produced by a similar electrical machine in a central station for the production of energy. Thus, if we connect the capstan of a railway station with an electrical machine either by gearing, or by mounting it directly upon the driving shaft, and pass through this machine an electric current, we shall produce rotation. Two turns of the rope round the capstan will be sufficient to draw the waggon or to make it revolve upon a turntable in order to join such and such a train at a goods station. But when we come to a practical application, the problem is not so easily solved. Experience has shown that the mean duration of the rotatory movements performed by these capstans is, as a rule, very short. As, moreover, the work is intermittent and the capstans seldom work simultaneously, the energy required could not be supplied economically by machines working continuously. During a period of 11 hours, the capstan most often used at the principal station of La Chapelle, notwithstanding all that is going on round about it, seldom works more than from 1 hour 40 minutes to 2 hours at the most, thus the utilisation of the energy supplied only amounts to 16 per cent. The engineers of the Northern Company therefore resolved to employ for electricity, as for hydraulic pressure, reservoirs of force acting only when required, *i.e.*, electric accumulators.*

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* *La Nature.*

We will now give a brief description of the arrangement adopted, an interesting specimen of which is to be found in the *Palais des Machines* at the Exhibition of 1889, on the first floor of the exhibition of the machines and instruments used by the Northern Company.

Mechanism.—Several systems have been tried. In all cases the capstan is worked by a little dynamo-electric receiver, but the transmission of the electric machine at the axle of the capstan may be effected either by friction-clutches or gearings in the case of an electric machine with an horizontal axle, or by direct action in the case of an electrical machine with a vertical axle coinciding with that of the head of the capstan.

We will here describe the second system, with gearings, which differs little from the two others and is almost identical with them as regards the result obtained. But, in our opinion, it is the last method, in the form of a multipolar dynamo, that will ultimately prevail, and which, moreover, is actually adopted in principle. The programme arranged and carried out in the capstan shown in the accompanying figures is as follows:—

The capstans must be able to furnish a force effort of 400 to 500 kilogrammes with a linear speed of ·6 of a metre per second at the periphery of the head or body of the capstan; the diameter of this head being ·4 of a metre, this linear speed corresponds to 70 revolutions per minute. The speed of the head of a capstan should be capable of being reduced, in case of need, to 12 revolutions per minute to turn locomotives upon the turn-table; this reduction of speed is effected by a simple modification in the couplings of the electrical parts, and by a lowering of the voltage from 200 to 100 volts. Finally the motive power of the machine, which must bear at least 25 ampères without deterioration, is supplied by lead accumulators of 25 kilogrammes.

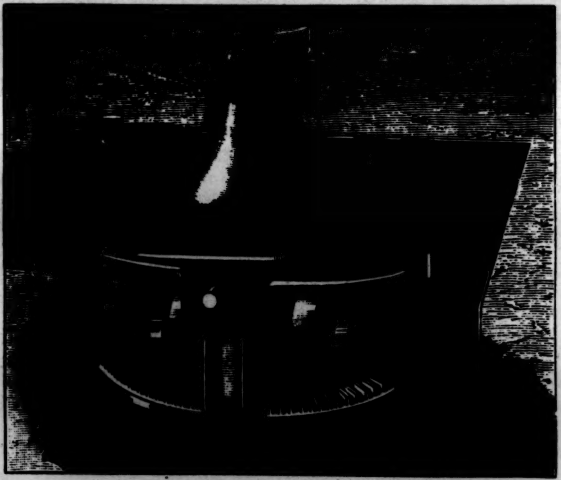

FIG. 1.

The apparatus exhibited in the Palais des Machines was constructed with great skill by a well-known electrical instrument maker, M. Hillairet, who has successfully carried out the programme laid down. This apparatus consists of a cast iron frame mounted on the vertical axle of a large toothed wheel, R, in which the pinions gear; on the axles of these pinions which turn in opposite directions are mounted the two armatures of the dynamo-electric receiver. All these parts are suspended in an air-tight vessel made of riveted sheet iron, covered with a plate of corrugated iron. The whole, frame and motive parts, swings round two pivots, G, in order to facilitate its being examined and attended to; chains attached to special hooks prevent its being completely reversed. The starting of the motive machine is effected by means of a pedal acting by means of a vertical rod upon a special commutator grouped into a triple combination which gradually brings in series or in parallel the different parts of the electrical machine and regulates the progressive arrival of the current.

Accumulators.—The loss for the line of electric conductors being estimated at one-tenth, the voltage at starting is 210 volts given by about 105 accumulators.

Each element of the accumulators is formed of seven plates, four positive and three negative, weighing altogether about 25 kilogrammes; the total capacity of each accumulator is, on an average, about 250 ampère hours, or 7 ampère hours per kilogramme of element, including the plate, vessel, liquid and accessories. The vessel containing the elements consisted of two polished glasses and three unpolished glasses fastened by special cement into an angular iron case, the angles of which are connected by joints of cast iron, the whole being coated with indestructible varnish. The plates are mounted upon four glass racks supported by two frames made of an insulating material not destructible by acids.

Results Obtained.—The experiment with the electrical capstans was made successfully more than a year ago at La Chapelle for turning the luggage vans, and at Paris for turning the tramway trains. The operation is very quickly effected, and for a capstan making about 60 rotations a day, each operation lasting about 30 seconds, it is sufficient to charge the battery of accumulators once every two days. This is evidently an application worthy of our attention and a step in advance of the hydraulic system, which itself has been brought to great perfection.

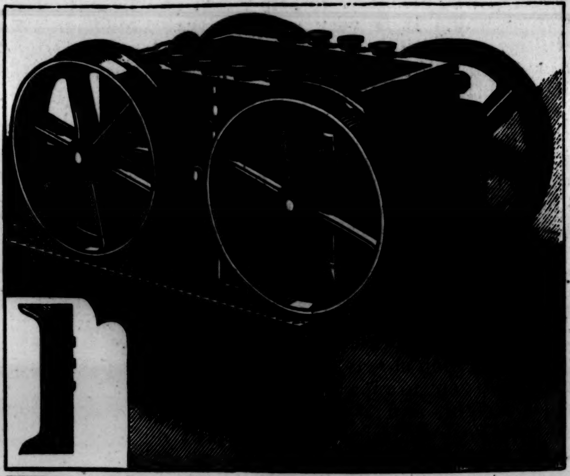

FIG. 2.

Electric Windlass.—We will conclude with a few brief remarks concerning the *electric windlass*, also exhibited by the Northern Company, and shown in fig. 2. It is intended for the loading and unloading of merchandise in sacks, such as sugar and grain, as a substitute for human labour, which is long and troublesome. It is a truck with four wheels, on which are mounted two electric machines, one of which moves the truck backwards or forwards along the line, and the other imparts to the hook of the chain the upward or downward movement, as required. According to the nature of the current sent into the first of these machines, the truck moves backward or forward; the transmission of the rotation of the axle of the induced part is effected by means of toothed wheels gearing into one of the axles of the truck. In the same way, with the second machine, the rotation of the induced part is communicated, in one direction or the other, through a toothed pinion, by means of a helicoidal screw gearing with a wheel round which is passed a chain to which the sacks are hung.

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* This is a new and bold idea for this particular case, and one which will certainly be widely imitated, to the great benefit of the progress of applications of electricity.

The source of electricity is, any dynamo-electrical machine whatever or a battery of accumulators capable of an output of 25 ampères at 100 or 200 volts at the terminals of the receivers.

The current is brought to the machines of the windlass, as shown in the figure, by spring contacts rubbing upon tongues of brass fixed upon wooden planks placed upon the inner edge of the rails.

With four men, including the stoker and the man who attends to the electrical machines, this apparatus is capable of stacking in less than 40 minutes a pile of 100 sacks, or, in 35 seconds, of taking up from a waggon, raising, carrying to a distance of 25 metres and depositing a burden of 140 kilogrammes, and then returning again to the waggon. This is a great advance upon the old way of loading and unloading by manual labour.

SIR WILLIAM THOMSON'S CHAIN OF ELECTROSTATIC VOLTMETERS.

By ANDREW W. MEIKLE, M.A.

(Continued from page 552.)

The Vertical Scale Voltmeter.

THE arrangement of the parts of this instrument will be readily understood from an inspection of the cut given in figure 9. The fixed portion of the condenser is formed by two vertical brass plates of the shape shown in the illustration. These are supported from the back of the metal case by two vulcanite knobs, and are fixed to each other by two cylindrical distance pieces, so as to be accurately parallel. The plates thus, as will be seen, form two quadrant-shaped cells similar to those of the multicellular voltmeter, but much larger in size, and having the space between them quite free from obstruction except at the two corners, where they are bound together by the distance pieces. The centre of the plates has a circular opening through which a brass arm with bearing plates and V guides passes from the back of the case. The movable portion is an aluminium vane which rests on knife edges on these bearing plates, and is kept in position by the V's, so that it is free to turn in a plane midway between and parallel to the fixed plates. The upper end of the vane carries a pointer which indicates the deflections on the scale of the instrument, while to the lower extremity is fixed a knife-edge for weights with its length perpendicular to the plane of the plate. The vane is adjusted to be in a state of neutral equilibrium by two sensibility screws, which turn one on a vertical and the other on a horizontal arm attached to the lower end of the vane. The shape of the vane has been somewhat changed lately, and as a result the scale divisions are much larger than in the earlier instruments.

FIG. 9.

The following improvements have also to be noted, whereby the convenience of the instrument has been increased. Two small guard rings passing over the knife edges are attached to the bearing plates, so that the movable plate cannot be displaced so as to make contact with the fixed portions. In order to prevent damage to the pointer, the range of motion of the vane is limited by two stop pins fixed into the back of the case. The left-hand stop is divided at half its length into two portions, one of which screws into the other. When the instrument is packed for carriage, the outer half of this pin is passed through a small hole in the top of the vane, and then screwed firmly into its position. When thus packed the vane is lifted from its bearings, and its knife edges are held in two slots cut in the guard rings. In this way the instrument is rendered very portable, and easily adjusted when set up for use. In the two types of the instruments formerly mentioned the scale is graduated from 0 to 60, and the divisions represent equal differences of potential—the actual value of the difference per division being dependent upon the weight in use at the time. A set of three weights, providing for three grades of measurement, in the proportion of 1 : 2 : 4, are supplied with each instrument. The constant is 50 volts per division with the smallest weight on, 100 volts per division with the first and second weights on, and 200 volts per division with all three weights on.

Standardising the Vertical Scale Electrostatic Voltmeters.

The vertical scale electrostatic voltmeters are usually graduated by direct comparison with standard instruments. In addition to the series of Multicellular Voltmeters, three instruments of the vertical type are kept for that purpose, the first of which has an effective range from 250 to 3,000 volts; the second from 400 to 8,000 volts, and the third from 800 to 12,000 volts. The first of these has a scale graduated from 0 to 150, and only two weights are used such, that with the first alone hung on the constant is 10 volts per division, while with both on it is 20 volts per division. This instrument is graduated throughout its entire scale, and the amount of its weights determined by using a Volta pile and series of Multicellular Voltmeters in the manner before described (fig. 6).

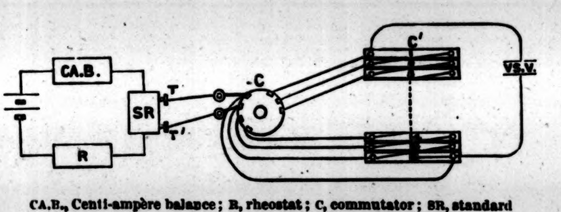
This low range Vertical Scale, A, can then be used to check the graduation of the next instrument, with range from 400 to 8,000 B. To do this the two voltmeters are joined in parallel with their terminals attached to the poles of a large Leyden battery. The first and second weights are hung on A, so that it can measure up to 3,000 volts, and the first weight only is hung on B. The Leyden battery is then charged, and while the potential is allowed to fall very slowly simultaneous readings are taken on the two voltmeters every 50 volts. A graduation of B is thus obtained from 0 to 60, such that with a certain weight on the constant is 50 volts per division; then by using four times this weight the constant is 100 volts per division, and by using four times the second weight, it is 200 volts per division. The third standard, with range from 800 to 12,000, is graduated in a similar manner by direct comparison with the two lower ones.

The second of the standard vertical scales has now been in use for some time, and at the date of its calibration the chain of Multicellular Voltmeters was not complete. It was therefore graduated by another method which is still employed as a check on the present system. The calibration of its scale was obtained as follows:—The instrument was joined in parallel with an auxiliary voltmeter, and their terminals attached to the two poles of the Leyden battery mentioned above. The battery was then charged to such a potential that the auxiliary instrument, X, gave a reading at a definite mark on the most sensitive part of its scale, and a weight of convenient amount was hung on the instrument being standardised, Y, so that it gave a deflection of about half its available range. The potential of the Leyden battery was kept constant by observing the indications on X, and the weights on Y were varied so as to satisfy the condition, $d \times \sqrt{W} = K$.

Where d is the point on the scale which it is wished to obtain W is the weight hung on the knife edge, and K is a constant.

For example, suppose it were agreed to call the point where the indicator stood with the first weight hung on 30, and the amount of the weight were 400 milligrammes, then the division 60 would be obtained by hanging on a weight of 100 milligrammes, while the weight to give the point for division 15 would be 1,600, and that for division 20 would be 900 milligrammes. Thus a scale was obtained graduated from 0 to 60, and, as the force of attraction between the movable and fixed plates of the instrument varies as the square of the difference of potential between them, the divisions represent equal differences of potential.

In order to find the proper weight to make this scale read 100 volts per division, a known difference of potential was multiplied by charging a number of condensers in series, and the voltmeter was used to measure the total voltage between the extreme terminals of the condenser pile. This method of multiplying potential was described by Sir William Thomson at the Aberdeen meeting of the British Association. A diagram of the arrangement is shown in fig. 10. The difference of potential between the terminals, T, T′, of the standard resistance is known, as explained above with reference to fig. 4, by the indications of a standard Centi-ampère Balance. The condensers, 16 in number, are joined in series, and wires brought from their terminals to commutator bars fitted on to a vulcanite disc; a movable arm actuated by a handle, and bearing two brushes, can be made to revolve round the circumference of the disc, so that the brushes are only in connection with two contiguous bars at one time. Wires pass from the terminals, T, T′, to two spring contacts in connection with the revolving brushes. The movable arm is made to revolve very rapidly, and by this means each condenser is charged in the same direction and to the same difference of potential betweeen their terminals. The difference of potential between the extreme terminals of the series will then be 16 times that between the terminals, T, T′, of the standard resistance. The insulation of the condensers must, of course, be very high to obtain good results by this method; but as an additional check, a Multicellular Voltmeter was applied in succession to the terminals of each condenser, and the sum of the readings on it was taken as the total difference of potential between the extreme terminals of the series. It was found that the number so obtained differed by about 3 volts on a total of 2,200 from that got by simply multiplying the difference of potential between the terminals of the standard resistance by the number of condensers. The Vertical Scale Voltmeter joined to the pile of condensers, as shown in the diagram, thus measured a known difference of potential, and knowing the amount of an arbitrary weight hung on its knife edge the weights were calculated to give the desired constants of 50, 100, and 200 volts per division of its scale.



CA.B., Centi-ampère balance; R, rheostat; C, commutator; SR, standard resistance; C′, condensers; VS.V., vertical scale voltmeter.

FIG. 10.

It is satisfactory to find that the instrument so standarised agrees excellently with the one graduated by comparison with a series of multicellulars, a fact which shows that observational errors in passing from the lower to higher ranges have been avoided.

(*To be concluded.*)

OBITUARY.

IT was with deep regret that we saw the announcement of the death of Mr. John Kaye Gray at Mentone, on the 5th instant, at the early age of 33. Although it was generally known that his health had, of late, been far from satisfactory, the news of his demise came as a very unexpected shock.

Mr. J. K. Gray was educated at University College School, completing his studies at Zurich and at University College. He subsequently joined the Silvertown Company's submarine cable staff, in which service he continued for several years, gaining during this period that experience and practice in mechanical applications which proved so serviceable afterwards. Later, he took charge of the India-rubber manufacturing department at the Silvertown Company's works in France, a post which he filled with marked ability and success.

Those who were associated with Mr. J. K. Gray in his various labours have to regret the loss of an energetic and hardworking colleague, and of a companion whose high spirits and good nature were proverbial.

He was buried in Wickham churchyard on the 12th inst., a large gathering of friends and fellow-workers testifying by their presence the esteem in which their late comrade was held, and a profound sympathy with his family, in which we desire to join.

SOME METHODS OF REGULATING ACCUMULATORS IN ELECTRIC LIGHTING.*

By GEORGE B. PRESCOTT, JUN.

IN preparing the following paper, the limited scope of which is indicated by its title, I have assumed that it is generally conceded that the modern electric accumulator is an apparatus capable of performing a peculiar, but useful, function in the art of electric lighting as now commercially practised, and that it is free from inherent defects which would render it unsuitable for such application. Indeed, I am sure that every careful observer has noted in the somewhat slow evolution of the accumulator, that structural improvement and adaptation to practical requirements, which unquestionably show that it has come to stay; and will acknowledge that, even as it exists to-day, the accumulator is a factor in electrical industry too important to be ignored by those who take a broad view of the situation.

It is not my intention to refer to those numerous successful applications of accumulators to the propulsion of small marine vessels and land vehicles, to car lighting and other minor work where the continuous generation of power from the combustion of fuel would be impracticable; neither can I fully discuss their characteristic actions under working conditions within the limits of this paper. Nevertheless, before proceeding to the subject proper, I deem it incumbent to point out that the electrical accumulator, even in its more improved forms, is an apparatus having well defined limits of capacity, and that these limits cannot be habitually exceeded without endangering its effectiveness and impairing its durability. Generally speaking the limits referred to, which vary with every type and size of cell, relate to the rate and quantity of charge and discharge, these factors being measured respectively in ampères and ampère-hours.

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* Paper read before the American Institute of Electrical Engineers, New York, October 29th, 1889.

In considering this admission, however, it should not be forgotten that dynamo-electric machines are, to a certain extent, subject to similar limitations; for, like the accumulators, if it is demanded of them, they are capable of generating a current far exceeding their safe carrying capacity. Here the likeness ceases, however, for while the dynamo will deliver its normal current as long as adequate power is applied to its shaft; by continuing to draw current from an accumulator for too long a time, as likewise from an excessive rate and quantity of charge, serious damage may result. In fact, in some respects an accumulator may be likened to a draught animal, which can be made to perform abnormally large amounts of work for short periods of time, but only at the expense of its vitality if the practice is frequent.

While much might be said regarding the maintenance of accumulators, and, moreover, the apparatus to be presently described is employed in a large measure for the purpose of effecting proper maintenance as well as regulation, it must suffice to say here that the normal working rate and capacity of an accumulator battery having been stated by the makers, all necessary data relating to its use may be ascertained from the indications of ordinary hydrometers, ammeters, and voltmeters. That is to say, during the charge and discharge of such a battery the rise and fall of its potential and of the specific gravity of the electrolyte in its cells, are both quantitatively indicative of its condition and capacity for doing work. It is evident from what has already been said regarding the importance of working accumulators within certain prescribed limits, that in order to effect this result two classes of apparatus must be provided with every accumulator installation—viz., indicating or measuring instruments, and regulating appliances to be operated either automatically or by hand. I am constrained to add here that careful and extended observation leads me to believe that a lack of appreciation of these now obvious facts will largely account for the ill-success attending many of the earlier accumulator installations.

Although there is reason for believing that some of the early promoters of business enterprises based on the manufacture of electrical accumulators, anticipated that accumulator systems of lighting were destined to compete with and perhaps supersede many direct systems, I believe that the more mature modern idea is that they are, for the present at least, mainly subsidiary to other electric lighting systems. As auxiliaries to many direct systems, accumulators undoubtedly effect a reduction in running expenses and add an element of reliability, besides accomplishing certain results that are not otherwise obtainable. In order to fully appreciate the truth of these statements it will be necessary to glance at the conditions commonly existing in ordinary isolated and central station plants as they are operated at the present time. Doubtless everyone who is familiar with the electric lighting business is acquainted with the vagaries of the load curves during each 24 hours of a central station's run. Generally speaking, about sunset the load begins to increase gradually, finally reaches a maximum which is maintained for a greater or less period of time, and then falls to a minimum about which it fluctuates for the remainder of the 24 hours. Almost every isolated plant, whether it be in office building, hotel or apartment house, has a curve of the same general character; and probably most manufacturing establishments would prefer to have a few lights burning through the night, if only for the watchman's convenience, were it not for the expense entailed by the continuous operation of the plant. It is a truism to say that the cost of fuel per horse-power increases inversely as the power plant operates below its normal capacity, and that other operating expenses are, to a considerable extent, fixed independently of the load. In view of these facts it is universally acknowledged that the operation of large power plants of any character during periods of light loads, is enormously wasteful. Many have hoped that the supplying of current to small electric motors during the day would remedy the evil in lighting stations, and to some extent the expectation has been realised in manufacturing centres, but even here the unfortunate overlapping of the motor and lamp service still leaves an undesirable margin.

Here, then, is a field in which accumulators may perform their special function; not in competition with direct systems, but as supplying the missing feature in the commercially successful operation of 24 hour plants of moderate size. There is no obstacle in the way of applying a sufficient number of accumulators to a plant of the character mentioned, to maintain the light load during the time it would not pay to operate the power plant, and to provide for the charging of the accumulators during the regular running time of the dynamos, Assuming, in illustration of this statement, that 10 hours is the ordinary working day, and that the engines of a central lighting station are started at 2 p.m., and are operated until midnight, it is probable, if not certain, that there will be sufficient surplus current for an ample length of time, to charge enough accumulators for the service required after the engines cease to revolve, excluding, of course, the period of maximum load, when the dynamos will be taxed to their full capacity in their regular service. Under such conditions the engines could be operated at somewhere near their normal capacity during the whole period of their running time, and the cost of unit power would be a minimum; while only one staff of men will be required. It may be advisable to explain here that although the current available for charging the batteries during the regular running time of the dynamos would vary with the lamp load, this is of no importance, as it is not essential that the batteries should be charged at a uniform rate. In the case of such stations as also supply arc lights, the engines could be started later and operated through the night. Besides reducing the operating expenses of a station during its period of light load to a greater extent than they increase them at other times, in the event of an accident to the power plant or incandescent dynamos, the accumulators can always be called upon for extra service; while, whenever there is an abnormally heavy demand for current they may also be operated in conjunction with the dynamos.

But there is still another field in which accumulators may be employed to equal advantage, viz., that of long-distance lighting now so successfully occupied by the alternator converter system. An accumulator is indeed merely a chemical converter, which is unequalled as a pressure-reducer, and anyone who gives careful thought to the subject will perceive what an excellent substitute it is for the alternator converter in those situations where the character of the lighting makes it necessary to run "light" for many hours each day. Indeed, I can only account for the fact that accumulators were not long since more extensively used for this class of lighting, except by the existence of a feeling of scepticism as to to their durability, together with their somewhat formidable first cost.

As manufacturers now guarantee the durability of accumulators, under certain conditions of use, for an annual percentage on their first cost, and as methods of manufacture must improve with experience, and moderate that cost, both of these objections are gradually being modified.

But even in the present state of the art, the question of first cost, depreciation and efficiency may be duly allowed for, and a considerable reduction in operating expenses still shown to result from the use of accumulators under many circumstances.

Before proceeding to consider the methods of regulating accumulator currents, it will be advisable to examine some of the peculiarities of the element with which we have to deal. Generally speaking, the total current capacity, expressed in ampère-hours, of a single cell of an accumulator of the lead-oxide type, is proportional to the number and size of its plates; its rates of discharge depending upon the number of plates and the effective surface of each, while the time of such discharge varies with their thickness. Although there are no obvious theoretical reasons why a single cell of an accumulator should not be made sufficiently large to possess any desired capacity, there are mechanical considerations which make it advisable to limit the dimensions of a cell to the extent that it may be conveniently portable. Therefore, when higher rates or longer discharges than an ordinary cell will give are demanded, two or more cells must be connected in parallel. On the other hand, the electromotive force of all sizes of accumulators composed of the same elements is of course identical, but as the internal resistance of a cell varies with the number and surface of its plates, its effective working potential must be a function of the strength of the discharge current. As, however, the internal resistance of all sizes of accumulators is, in virtue of the large surface and compactness of their electrodes, exceedingly small in comparison with their rate of discharge, their working potential nearly equals their electromotive force on open circuit. While the normal effective working potential of a fully charged accumulator in good condition is usually stated as about two volts, as a matter of fact it is somewhat higher than this after being charged and rather lower after normal discharge, the average effective potential being about 1·95 volts. During the operation of charging an accumulator its potential, or what is then usually called its counter electromotive force, rises gradually until the cell is nearly charged, and then more suddenly as gas is evolved, sometimes requiring an effective charging pressure of as high as 2·5 volts per cell if the current is continued after the cell is charged. In actual practice the accumulator is usually considered to be fully charged when the potential of the normal charging current reaches 2·3 volts per cell, or at 2·2 to 2·25 volts per cell when the charging rate is reduced as gas begins to be freely evolved toward the end. Similarly when a cell is discharged at the normal rate its effective potential falls during the progress of the discharge from 2 volts to 1·8 volts, at which latter point it is considered to be discharged to its normal limit.

The facts above cited to the effect that the electromotive force of accumulators rises during charge, and falls during discharge, and that their capacity for charge and discharge is limited, are the keynotes to the regulative processes; and only one other point need be here considered. When two or more series of cells connected in parallel are to be charged at the same potential, it is evident that unless each series is in precisely the same state in respect of residual charge, there will be a difference in their electromotive forces; and in consequence less current will flow in those series having higher potentials than others. While the larger current flowing into the less charged cells will have a tendency to bring up their potentials to the average, it is found in practice that some series will become fully charged sooner than others. The simple means provided for compensating for these variations will be duly described.

One of the commonest, and perhaps the simplest, applications of accumulators to lighting work is found in their employment in connection with direct isolated plants in factories, office buildings, &c. In illustration of the method of applying accumulators in such cases, we may select as a type of this class of lighting one of those office buildings common in New York and other large cities. This building, we may assume, has already been, or is about to be, wired for 500 16 candle, 100-volt, ½-ampere lamps on the multiple arc plan, and is to be provided with a 125 volt, 200 ampere dynamo; it being calculated that more than 400 lamps will rarely be lighted simultaneously. We are not specially concerned with the power plant, and will simply assume that it is of ample capacity, it being remembered that such buildings are usually steam heated, and, therefore, offer favourable conditions for the operation of a plant of the character under consideration. Now it can be deduced from experience that, during the day, from, say, nine o'clock in the morning until about sunset, only a limited number of lights will be burned in certain dark corners of the building, and that, as twilight and darkness come on the load will gradually increase, reaching a maximum at a certain hour depending upon the season; subsequently the load will decrease, finally reaching a minimum after the janitor and his assistants have finished their cleaning operations, which load will probably be maintained for the remainder of the 24 hours. It is evident that a direct plant operating under such conditions would necessitate the employment of two forces of men, either one or two in each, and would, moreover, be running under exceedingly uneconomical conditions for a large part of the time. Let us now consider in what manner accumulators may be added to this plant in order that it may supply the variable load for 24 hours daily, while at the same time dispensing with the services of one staff of men and reducing the running time of the engine to eight hours.

It has been shown in a general way how the load varies during 24 hours; but in order to ascertain the capacity of the accumulators required, it will be necessary to assume, though only approximately, somewhat more precise figures. Say that the load is as follows:—

From 9 p.m. to 9 a.m., 20 lamps = 120 ampère-hours.
„ 9 a.m. to 4 p.m., 200 lamps = 700 „ „
„ 4 p.m. to 6 p.m., 400 lamps = 400 „ „
„ 6 p.m. to 9 p.m., 50 lamps = 75 „ „

An inspection of the above schedule shows that for 12 hours out of the 24 only 20 lamps, or 10 ampères, are used, while for three hours more only 50 lamps, or 25 ampères, are required, and a simple calculation proves that a set of accumulators having a capacity of 200 ampère-hours, will be amply sufficient to maintain the light lamp load for 14 hours out of the 24. If the dynamo is started at 8 a.m. and operated until 6 p.m., while maintaining the required number of lamps during that period it will still have surplus current for charging the battery as follows:—

From 8 a.m. to 9 a.m., 190 ampères for 1 hour.
„ 9 a.m. to 4 p.m., 100 „ „ 7 hours.

or 890 ampère-hours, an available capacity vastly in excess of the requirements. Now, if during the eight hours in which the dynamo is operating, the accumulators are charged at the rate of 30 ampères, in that period they will receive a total charge of 240 ampère-hours. According to the schedule, the maximum output required from the battery will be 185 ampère-hours, whence it follows that the charge received by it is more than ample, even after making the customary allowance of 20 per cent. for loss by conversion; and the desired result has been accomplished.

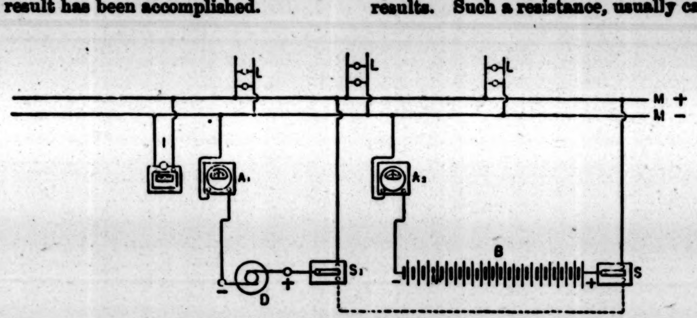


Fig. 1

We have now to consider the details pertaining to the practical arrangements of such an installation. According to the stipulated schedule, after the dynamo ceases to run at 6 p.m., the battery alone must supply 25 ampères for three hours, and thereafter 10 ampères for 11 hours, or a total output of 185 ampère-hours. One series of 50 cells—having, say, a normal capacity of 30 ampères for eight hours—will satisfy these requirements, and will be well within the nominal rating of ordinary commercial cells. Assuming that these 50 cells, connected in series, have been suitably placed on insulated shelving at any convenient distance from the dynamo, they may be electrically connected with the latter and with the lamp circuit, as shown diagrammatically in Fig. 1.

In this diagram the two parallel wires M (+), and M (—), represent the common dynamo and lamp mains to which the pressure indicator, I, is permanently connected in the usual manner, and L L L, represent the lamp circuits. The dynamo, D, is connected to the mains through the ammeter, A_1, on one side, and through the upper contact of the two-way switch, S_1, on the other. These are the ordinary connections of a multiple arc plant; and the (+) and (—) terminals of the accumulator battery, B, are also connected with the mains through the ammeter, A_2, and two-way switch, S_2, in precisely the same way. It is evident that if the levers of both switches, S_1, S_2, are against their upper contacts, the dynamo and battery will supply current to the lamp circuits in exactly the same manner as would two dynamos connected in parallel, provided, of course, that they are both at the same potential. On the other hand, if the potential of the dynamo slightly exceeds that of the battery, the current from the former will divide between the battery and the lamp circuit in a certain proportion determined by the ratio of the resistance of the lamp circuit to the internal resistance and counter electromotive force of the battery. If the levers of the two switches, S_1, S_2, are now moved to their lower contacts, the dynamo and battery will be connected in series with their like poles opposed, the main M (—) acting as part of the circuit; and supposing that the pressure of the dynamo still exceeds that of the battery, the latter will receive a charge. Thus, by this very simple arrangement, the dynamo and the battery, either separately or together, may be connected with the lamp circuit, or with each other, or be entirely disconnected.

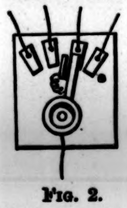


Fig. 2.

While this method satisfies all but one requirement in certain classes of plants where it is convenient to employ the dynamo solely for charging the battery during a part of the day, and to use either the dynamo or battery, or both, in the lamp circuits at other times, it does not, in fact, satisfactorily permit of that splitting of the dynamo current between the lamps and battery which was incidentally referred to. More than this, it fails to provide a means of compensating for that rise and fall of the potential of the battery during charge and discharge which has been mentioned, and this is the unsatisfied requirement referred to above. The reason why the dynamo cannot satisfactorily divide its current between the battery and lamps when connected in the manner illustrated in fig. 1 has already been pointed out. During the charging of the battery its potential will rise to 2·2 volts per cell, so that the pressure of the dynamo must be raised to 110 volts in the case now being considered, and this excessive pressure would endanger the life of the lamps. How, then, will it be possible to employ the higher pressure demanded by the battery and at the same time supply current to a number of lower voltage lamps without raising their candle-power above normal? The answer is easily given, for it is only necessary to insert a suitable resistance in the main between the dynamo and lamp circuits in order to accomplish the desired results. Such a resistance, usually called a "pressure equaliser," should be made of wire sufficiently large to safely carry the current for the greatest number of lamps likely to be required at the time when the dynamo which supplies them is to be simultaneously called upon to charge the battery, and should be made conveniently adjustable, as the fall of potential through it varies with the current. The method of regulating the working potential of the battery is equally simple, for it merely consists in adding to, or subtracting from, the number of active cells in circuit. This is accomplished by means of a multiple point switch, called a cell-regulating switch, shown diagrammatically in fig. 2, which is so constructed that, in the act of shifting the cells in and out of the circuit, neither interrupts the circuit nor short-circuits the cells. It consists essentially of a single pivoted lever, which carries on its outer end a short metallic arm. This arm is attached to the lever by means of a block of insulating material, but it is electrically connected with it by a short spiral of German silver wire. The lever and arm may be made to pass over a number of contact strips, which are so arranged that, before the lever breaks contact at one strip, the arm comes in contact with the next strip, and the reverse action takes place when the lever is moved in the opposite direction. During the brief interval while both lever and bar are in contact with adjacent strips, the cell connected to those strips discharges a feeble current through the spiral of wire.

It is necessary to mention here that in practice it is customary to provide for the installation of 10 per cent. more cells in each series, than a simple calculation on the basis of two volts per cell would show to be necessary. Thus a plant using 100 volt lamps would require 100 ÷ 2 = 50 cells + 10 per cent. of 50 = 5, or 55 cells in each series. This allowance is usually sufficient to compensate for the fall of potential during discharge, as well as to provide for the ordinary loss of potential in the lamp mains.

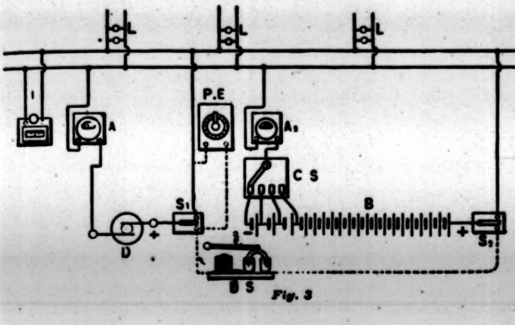


Fig. 3

The method of employing the pressure equaliser and cell regulating switch is shown in fig. 3, this diagram being otherwise similar to fig. 1, with the further exception that an automatic break switch, B, S, is inserted in the branch wire connecting the dynamo and battery through the lower contacts of the switches, S_1 S_2. The function of the automatic break switch is merely to interrupt the charging current, in the event of the potential of the dynamo becoming so much reduced from any cause as to allow the battery to overcome it, and perhaps reverse its polarity. This switch consists of a simple electro-magnet with a weighted armature lever carrying at one end an ⋂-shaped bent wire dipping into mercury cups. The charging current passes through this magnet and from one mercury cup to the other through the bent wire. When the current becomes greatly reduced to any predetermined extent, gravity overpowers the attractive force of the magnet, its armature is released, and the bent wire being drawn out of the mercury cups, the circuit is broken. By referring to the diagram in fig. 3, it will be seen that the pressure equaliser, P, E, has been so placed that when the switches, S_1, S_2, are on their lower contacts, the current from the (+) pole of the dynamo will divide at switch, S_1, part going through the battery and part through the pressure equaliser to the lamp circuits, both currents again uniting at the M (−), main to return to the (−) pole of the dynamo. By this arrangement the potential of the dynamo may be adjusted to the requirements of the battery, and at the same time the pressure at the lamps suitably reduced by adjusting the resistance of the pressure equaliser.

When the proper balance is once obtained, and by means of this apparatus it may be quickly and easily accomplished by one man, no further attention than would ordinarily be given to the dynamo would be necessary, for although the counter potential of the battery would gradually rise toward the end of the charge and the current passing into the battery become correspondingly reduced, this result is even desirable, as it is somewhat advantageous to reduce the strength of the charging current as the battery becomes filled. In some installations, however, the extra, or regulating cells are used to a more limited extent than the others, and thus having had less current taken from them, they become sufficiently charged in a shorter time. A simple movement of the cell regulating switch will then serve to cut out of circuit one or more of the charged cells as may be required, while the others receive current for a longer time. In some cases a further adjustment of the field rheostat of the dynamo and of the pressure equaliser may afterward be required, and if so, are quickly effected.

The first indication that the cells have received nearly enough charge will be given by the gentle evolution of gas which gradually increases thereafter, and which should never be allowed to become violent. At the same time the potential of the battery will approach 2·2 volts per cell, and even reach above 2·3 volts per cell when the gasing become marked. In order to take advantage of their indication of charge it will be sufficient to have a voltmeter conveniently located, and connected with the terminals of the battery, by means of which instrument, the number of cells in the battery being known, the potential per cell is readily ascertained. While this increase in potential is taking place, a similar variation in the density or specific gravity of the electrolyte in the cells also occurs, but this change, unlike that of the potential, remains fixed, even after the charging current is discontinued. That is to say, if the specific gravity of the liquid was 1·160 when the cells were normally discharged, it would rise to 1·190 when they were fully charged, and would remain at that for a considerable length of time if no current was drawn from them. This rise of ·030 in the specific gravity of the electrolyte is about the average increase in density which takes place in the common types and sizes of accumulators when 1·160 acid is used in the original charge, and when the range is from normal discharge to full charge. It often happens, however, that charging is commenced when the cells have more or less residual charge, and in this case the rise in specific gravity will be correspondingly less; while, on the other hand, it will be correspondingly greater if the cells were previously over-discharged. Again, if unusually large containing cells inclose the piles (as the aggregation of electrodes is commonly designated) the rise of specific gravity will be smaller, and, on the other hand, larger, if unusually small containing cells are employed. As heretofore stated, a similar drop in specific gravity and potential occurs when the cells are discharged, which in degree has about the same value as the rise. This variation in specific gravity is explained by the formation of lead sulphate during discharge, which implies the absorption of acid from the electrolyte, and by the reduction of this sulphate during the charge when the electrolyte is strengthened.

While the method of installing a single series of accumulators in connection with an isolated plant, as described and illustrated in fig. 3, fulfils most of the conditions required in small plants operating a single dynamo; in larger plants of a similar type using two or more dynamos, several series of the largest cells may be required. Although such an installation would consist mainly of an amplification of the system already described, still there exists a new difficulty not met with in that system. This arises from the fact already mentioned, that when several series of cells are charged in parallel, any essential difference in the amount of the residual charge in the several series, results in their allowing different amounts of current to flow through them, although all of the series are charged at the same potential. The remedy for this undesirable result is of the same character as that employed to prevent excessive pressure on the lamp circuits, when the dynamo which supplies them with current is at the same time used to charge accumulators. In circuit with each series of cells is placed a small adjustible resistance coil, called a current equaliser. It is composed of wire large enough to carry the maximum current of a single series of cells, and usually has a resistance of from $\frac{1}{10}$th to $\frac{15}{10}$ths of an ohm. Each series of cells is also provided with an ammeter, and upon the commencement of a charge the current equalisers are so adjusted that each ammeter shows the same amount of current to be passing through each series. In order to avoid as much as possible any loss of energy in the current equalisers, they are all turned to the no resistance point at the start, and resistance is then only inserted in such series as may be taking more current than others.

The general arrangement of an accumulator plant consisting of two dynamos and two sets of batteries is illustrated in fig. 4, and a simple extension of this plan only is necessary to adapt any number of series of cells to a plant having any number of dynamos. It will be seen that one equaliser circuit, and one charging circuit with its automatic cut-out, are common to all the dynamos that may be used. While this arrangement possesses all the flexibitity of the method of installing a single series of cells as shown in fig. 3, it has the additional advantage that at such times as the load is below normal, a spare dynamo can be exclusively employed for charging the cells, and thus avoid loss of energy in the pressure equaliser. As a general thing when the current equalisers, C, E, have once been adjusted at the beginning of a charge they need but little, if any, further attention, still if from any cause one series of cells should happen to be over discharged, or discharged more than the remaining series, a suitable readjustment of the current equalisers will permit the undercharged series to receive current at a higher rate than the others, and thus equalise itself with the others. It may also be mentioned that both the pressure and current equalisers may be made to operate automatically by the application of a potential magnet to the former and of a current magnet to the latter, together with a simple but somewhat expensive train of gears to move their levers. This is found to be wholly unnecessary in practice, however, as an engineer is usually in constant charge of such a plant while the dynamos are running, and he can easily devote the little time necessary to the infrequent regulation required.

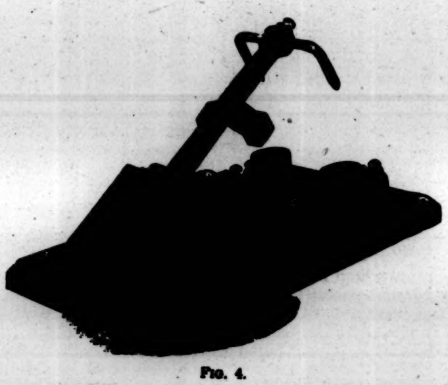


FIG. 4.

It was mentioned in the early part of this paper that it was possible to injure accumulators either by over-discharging them or working them at too high a rate. It is assumed that, in the larger plants, there will be such supervision available under ordinary working conditions that occurrences of this kind will be avoided; but a simple device for preventing such abuse of the cells in smaller plants, where such supervision is not always convenient, has been devised. It is called an overload and overdischarge switch, and its operation is based on the fact that, when a series of cells is overdischarged, their potential falls below a minimum value, and that when they are worked above their normal rate the current exceeds a maximum value. The apparatus consists essentially of a pressure magnet connected to the terminals of the battery, and of a current magnet in series with the battery; when the potential of the battery falls below a minimum value, the armature of the potential magnet is released and throws an artificial

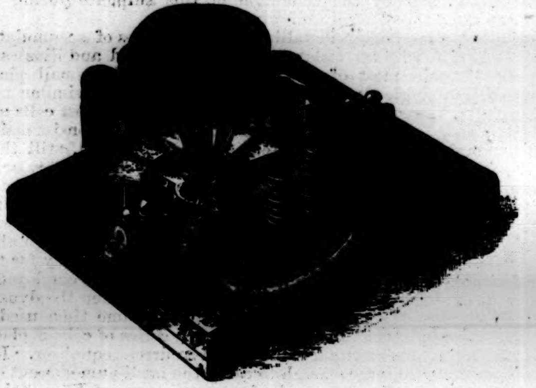


FIG. 5.

resistance into the battery circuit, and thus reduces the current; and similarly, when the current exceeds a maximum value, the armature of the current magnet is attracted and performs a similar function. The connections of this overload and overdischarge switch, C and P, are shown diagrammatically in fig. 5, n which a common resistance, R, serves for either magnet. The battery current passes from A to B through the overload magnet, while the terminals of the overdischarge magnet are, as before stated, in shunt to the battery terminals. In fig. 6 is illustrated a practical form of a combined overload and overdischarge switch.

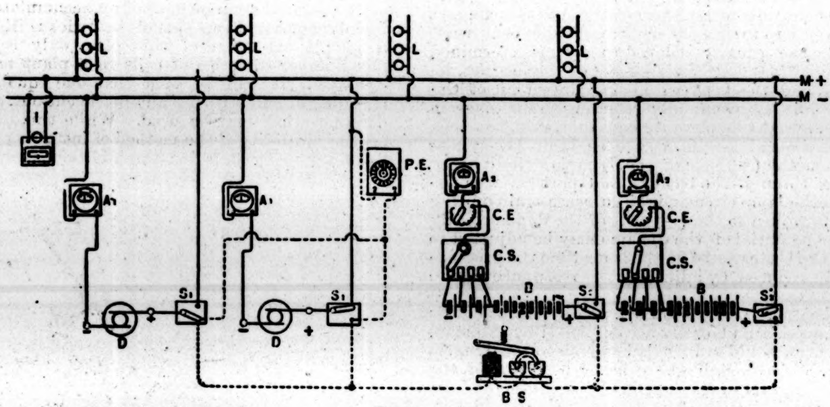


Fig. 6

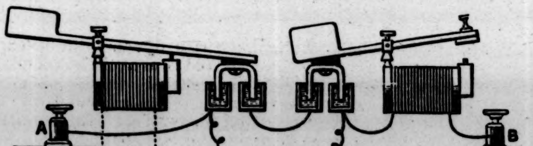


FIG. 7.

With the object of reducing the cost of the regulating apparatus whenever both the combined overload and overdischarge switch and the current equaliser are to be used with the same series of cells, the switch portion of the equaliser may be mounted on the resistance frame; and thus a single resistance coil may be made to do service for both instruments. This combination, of which the connections are shown in fig. 7, while allowing the current equaliser switch to control the full range of the resistance, at the same time causes the whole coil to be thrown into the battery circuit upon the operation of either the overload or overdischarge switch. This, of course, diminishes the brilliancy of the lamps, and thus indicates the state of affairs to those interested.

(*To be continued.*)

Electric Lighting at Tiverton.—At a meeting of the Tiverton Town Council on Monday, it was resolved to apply for a provisional order.

NOTES.

Ayr and the Electric Light.—The Ayr Town Council on Saturday unanimously resolved to apply to the Board of Trade for a provisional order to light the town with electricity. It was calculated that an electric installation for Ayr would cost from £18,000 to £20,000.

Lighting in Cumberland.—Messrs. R. R. Buck and Sons, manufacturers, of this city, have successfully fitted up their works at Dalston, Cumberland, with the electric light, much to the satisfaction of the operatives.

Electric Lighting at Hastings.—At a special meeting of the Town Council last week, Councillor Jenners moved that the Corporation apply for a provisional order to enable them to supply electricity, and it was ultimately decided to do so.

Lighting a Mill by Electricity.—The Thorverton Roller Mills have recently been fitted up with an installation for the supply of the electric light. The work is now completed, and the new illuminant gives entire satisfaction. The arrangements have been carried out by Messrs. Christy, Son & Norris, electric lighting engineers of Chelmsford.

Electric Lighting Acts.—The *Financial News* says: —One effect of the Electric Lighting Acts, which, perhaps, has not received sufficient attention hitherto, will now come into prominence. Throughout the country—north and south and east and west—electric lighting companies have given notices of the intention to apply for provisional orders. In some cases they have been allowed to proceed without opposition or rivalry, but in many others local authorities have been roused into action, with the result that it is proposed to spend the money of the ratepayers in carrying out the programme which was originated by joint-stock enterprise. Preference is to be given to a local authority if the intention to supply the electric light is *bonâ fide;* but it is a considerable hardship that shareholders' money must necessarily be expended in taking steps which, owing to the tardy action of a municipal body, the Board of Trade must needs nip in the bud. If the consent of a local authority to the introduction of electricity within its area is to be indispensable, it would be just and reasonable that the company which is first in the field should be repaid the outlay which stirred the local rulers into activity for the public good.

Electric Lighting at Windsor.—The Windsor Board of Guardians has refused an application to the Windsor and Eton Electric Lighting Company for a provisional order to light the district with electricity. The Windsor Town Council has countenanced the application of two companies.

Swindon Lighting.—Tenders are required by the New Town Local Board for lighting Swindon by gas, or other illuminating power, commencing January 1st, 1890. Further particulars can be obtained on application to Mr. H. Kinneir, clerk, New Swindon.

The Prize Electro-Motor.—The prize offered by our contemporary, *Industries*, has at last been awarded to a design by Messrs. F. V. Andersen and J. O. Girdlestone. We give below the results of the tests. The motor is of the double magnet type, the armature having Pacinotti projections and being drum wound. On test the results given were :—

Electrical H.P. supplied.	Speed of Motor spindle.	Mechanical H.P. given off motor spindle.
11·81	248	7·31
14·85	285	10·60
12·70	252	9·48

The motor is series wound, the resistance of the armature being 0·065, and that of the field 0·061 ohms; total, 0·126 ohms. The weight of the motor without pulley is 8 cwts. 3 qrs. 5 lbs. It is designed to work with a current of 150 volts pressure, and a speed of motor spindle of 250 revolutions per minute. According to the terms of the competition, the weight was not to exceed 950 lbs., the speed of the motor spindle was not to exceed 250 revolutions per minute, the pressure was not to be less than 100 or more than 500 volts, and a commercial efficiency of 80 per cent. should be aimed at. The prize motor, although falling short of this standard of perfection, has been considered by the Judges to come sufficiently near it to merit the award. The judges were Mr. W. H. Preece, F.R.S., Prof. G. Forbes, M.A., F.R.S.E., and Prof. Grylls Adams, M.A., F.R.S. Mr. F. V. Andersen is an old contributor to our pages, and we congratulate him and his colleague on their achievement.

A Policeman's Life, &c.—Sergeant McDonald, of that urbane and polite force, the New York police, was called to remove an obstruction in the roadway, caused by a derelict wire, and after the usual manner of his kind, went for this wire with his drawn club; the wire, however, hit him one on the head, which shocked him into insensibility. The police were of no further use; the obstruction remained until the skilled linesmen came on the spot. It must have been a new experience to the gallant sergeant, who will no doubt recollect in future that even a (wire) worm will turn.

Funny Folks at Gravesend.——The question of lighting the borough of Gravesend with electricity, and in connection with which it was resolved at a previous meeting of the Town Council to give consent to all the companies applying for provisional orders, has been reopened, it having been ascertained that the giving of consent to the whole would deter any of the companies from moving under these conditions. The consequence has been the moving of resolutions favouring the municipal company with provisions that they commence operations within 12 or 15 months or forfeit £500 to the Corporation. These resolutions have been opposed by several prominent members, including Alderman Edmonds, the Deputy-Mayor, whose particular objection appeared to be that the capital was £25,000 in £10 shares and the directors qualification being £25, whilst other councillors advocated the formation of a local company. Some discussion also ensued in committee as to the power of shareholders in the gas company taking part in discussions on lighting questions, but this was overruled as not pertinent, the question not being one of gas *versus* electric light. After other "edging" discussion had been introduced it was resolved, in direct opposition to the previous decision of the Town Council, that no consent should be given to any of the companies, this decision being upheld by eight votes to seven.

The Otto Gas Engine.—The Secretary of the late Birmingham Exhibition informs us that a special gold medal was awarded by the jurors to Messrs. J. Wright and Co. (who exhibited for Messrs. Crossley Bros.), of Birmingham, for Otto gas engines, but by some oversight their name was omitted from the list sent to us and, we believe, to other papers.

Telegraph Communication with China.—The *Times* says :—It is reported from China that the telegraphic convention between the Great Northern and the Eastern Extension Companies, and the Chinese Government, which was negociated two years ago at Chefoo, has at last been signed by Li Hung Chang and M. Coumany, the Russian Minister at Pekin, on behalf of the two companies. Under it the Chinese telegraph system will be connected with the Siberian lines at Kiachta. In all messages to Europe the Chinese Administration will be allowed to charge 5 f. a word to Kiachta, the Russian line charging 3¾ f. for the rest of the way. It is also reported that the Chinese lines are to receive a subsidy from the two cable companies of about £30,000 a year. The convention is to last for 14 years, and its practical effect is that telegrams from China will remain at $2 a word. The convention has not yet been made officially known, but these are the terms as published in China, and they have caused much dissatisfaction in the foreign mercantile communities.

Personal.—Mr. J. F. Moulton, Q.C., has been elected a Bencher of the Honourable Society of the Middle Temple, in succession to the late Judge M'Intyre, Q.C.

Electricity and the Mormons.—The *Western Electrician* says street lighting by electricity will soon be introduced into Salt Lake City. It appears that the electric light wires are strung on the same poles as the telephone wires, and in many instances within a few inches of them. Commenting on this fact, a local electrician predicts that there will be by no means mild remonstrances from the telephone company when the electric lights are started up.

The National Telephone Company, Limited.—The annual supper of the employes of the National Telephone Company, Limited, took place last Friday night at Glasgow. The chairman, Mr. D. Sinclair, in the course of a short address, mentioned that it was 12 years since the company started in Glasgow in a very small way. They had now 3,134 subscribers, and during last year alone had put in 548 new wires. In Glasgow the wires now extended to a total length of 3,440 miles, the increase during last year being 1,000 miles, and the exchanges in the city numbered 30. The company throughout Great Britain had altogether 26,632 subscribers, using 32,040 miles of wire, and making an average of 230,688 calls per day. In Glasgow the average number of calls per day was 30,341, or 9·86 calls for each subscriber. Several toasts followed, and a number of songs were given by gentlemen present.

Enterprise.—On Saturday night Mr. W. J. Corse, Devonport, lighted up his business premises with electric light, the installation having been completed by himself.

Alleged Theft of Electric Bells at Darlington.—The *Northern Echo* says: George Todd (about 18) was remanded on Monday on a charge of stealing electric bells from Mr. Cox-Walker, of Darlington, with whom he was apprenticed. It was stated that prisoner had been making bells and selling them to people in the town, and that when it became known to his employer he absconded and paid his passage at Stockton on a steamer for London.

The Cable at Rye Station, America.—The shore end of this cable, owned by the Direct United States Company, is laid among the stumps of a submerged forest. Last spring the tides had worn and worked all the sand and gravel away, leaving the cable bare. Usually cables are buried in trenches three or four feet deep, but in this case the cable lies fully in view as it runs up to the cable station. The cable is the ordinary single conductor shore end. The iron sheathing is entirely intact, and bears no sign of decay. The cable goes from Rye Beach to Halifax, N.S., and is there connected to the cable from Halifax to Ballinskelligs Bay, on the coast of Ireland, a distance of 2,400 miles. The stumps among which the cable lies are very large, measuring 8 feet or 10 feet in circumference. They are mostly of cedar, and are of a rare quality not known, it is said, to exist in forests of the present age. The forest extends out a considerable distance.

The "Ohm" Memorial.—The Committee of the "Ohm Memorial Fund" announces that the subscription list is now closed, the amount collected being £125. As modest contributors we must, however, disclaim the honour of any connection with the *Electrician Printing and Publishing Company*, and we scarcely recognise ourselves as being represented by our esteemed friend Mr. W. H. Snell.

Manchester.—It would appear that the prevailing opinion relative to the electric lighting scheme of the Corporation, is that the area chosen is far too small for a successful issue, especially as the area embraced is almost entirely an early closing portion of the city, and there are probably few places which would require the light after 7 p.m. Strangely enough, the Town Hall is just without the boundary. The lighting is to be carried on under the constant current low-pressure system, and it is understood that Mr. Shoolbred has been consulted on the system to be adopted.

An Electric Lighting Age.—If all the schemes for electric lighting which are officially scheduled are carried out many of the leading towns in England will soon enjoy the most recent method of illumination.

Dundee.—The Town Council will apply for a provisional order.

Provisional Orders.—The number of applications to the Board of Trade has now reached 430, and power to apply will remain open until the 30th inst.

Action Against the Taunton Electric Light Company.—An action has been brought by a lady, Miss Harrison, against the above company for an alleged trespass by the defendants' wires being attached to the chimney of her house. After a great deal of evidence had been given decision was reserved until next month's court.

Messrs. Immisch's Mining Plant.—A successful experiment was carried out at Normanton on Wednesday of Messrs. Immisch's pumping and hauling plant. There were a good many visitors from all parts of the country.

The London Electric Supply Corporation.—When is the lighting of London from Deptford to commence? The delay must have the effect of making the shareholders anxious, and we notice that the quotations for shares of the company are steadily lacking, £5 shares being now quoted, $4\frac{1}{8}$ to $4\frac{3}{8}$.

The Chattanooga Accident.—*Electric Power* of New York, referring to the recent electric tramcar accident, says:—"It cannot be expected that the rapid growth of electric railways throughout the country can continue without a certain percentage of accidents, possibly involving the loss of life or limbs. That which occurred on September 20th at Chattanooga, however, conveys a warning which it will be well to heed. It appears to have been caused by the attempt to drive a heavily-laden car up a steep grade, the rails being moist with dew. The force of gravity was in excess of the tractive effort, and of course under the circumstances any ordinary braking system was useless. The conductor was placed in the position of deciding at once which of two things the passengers should do—stay on the car or jump off. The latter alternative was chosen, and of those who followed his advice two were, perhaps, fatally injured, and a dozen or more less seriously. Relieved of its excessive burden the car was brought under control and stopped; but the newspaper report states that the car which followed was reversed upon the 'motorneer's' discovery of the danger of a collision, and we may therefore place to the credit of the electric car that it may be instantaneously reversed, thus introducing an element of safety in street railway practice that should at least counterbalance any liability to accident. It is well to understand, however, that there is a safety limit in the climbing of grades by a self-propelled motor, that for the general welfare of the public as well as for business reasons should not be exceeded. We must admit that we have feared the possibility of an accident of this nature, and it now appears necessary that on roads where heavy grades are to be encountered, suitable track brakes should be provided for use in an emergency of the character in question.

A Proposed Central London Railway.—At last there seems a possibility that the congested state of certain most important thoroughfares will be relieved. The scheme appears to be well backed up by influential City gentlemen. The preliminary powers have been applied for, and shortly we may hear that work has been commenced. The engineers to the undertaking are Messrs. Fowler, Baker and Greathead, whose recent operations have attracted considerable attention. Briefly, it is proposed to construct two iron-lined tunnels, about 11 feet in diameter, deep below all sewers and pipes, and well below the gravel upon which the houses are built, so that the tunnels being in the solid clay, there will be no trouble from water, and no settlements can possibly arise, as the tunnels will be driven under the protection of a steel shield, such as was successfully used by Mr. Greathead recently in driving the tunnel under the Thames, close to, and below the level of the foundations of London Bridge. No shafts will be made in the streets at any point, but all the clay excavated will be brought to the surface by shafts on the company's private property alone. We should imagine the work along Holborn, Newgate Street and Cheapside should be comparatively easy, as there still exists all along the proposed route the Pneumatic Despatch Company's iron tube, which is about 4 feet 6 inches in diameter.

A Correction.—Mr. Lewis, the general manager of the Western Counties and South Wales Telephone Company, Limited, sends us the following:—"In your issue of the 15th inst. there is a paragraph under the head of 'Telephonic Communication in the West.' in which you state that 'this company is rapidly extending its operations, and have *reduced their charges by one-third in all the towns connected with their trunk lines.*' We have in a few solitary cases in South Wales reduced our toll charges from 1s. and 9d. to an all-round rate of 6d., but your paragraph, as it stands, is very misleading.

Edinburgh Town Council.—The members of this body appear to be arriving at a state which, in relation to the electric lighting of the city, may be described as foggy.

Insulation.—A correspondent writes:—"A whole lot of subscribers are very anxious to know how the new patent insulating material used on the machines and mains at Deptford stands the 10,000 volts?"

Electrical Register.—One of the latest American inventions, and one that has not yet been made public, is the "electrical register." It is intended to be used for a variety of purposes. A series of buttons along the inside of a horse-car, within easy reach for the conductor, connect with the register at the end of the car. By pressing one of these buttons the fare is registered, and the announcing bell rings simultaneously. In the system used at present the conductor pulls the leather strap, which rings the bell, and the fare is registered by the return action of the belt. It is said that in the present method the gong can be rung without registering the fare by skilful manipulation. Again, in unloading a ship, switches can be so arranged that each parcel of similar size, as in tea cargoes, registers as it passes the electrical connection.

The Chelsea Electricity Supply Company, Limited.—In order to carry further the work of this company a second issue of ordinary shares is announced.

New York Telephone Subscribers Dissatisfied.—A number of telephone subscribers met in the rooms of the Board of Trade on the 28th ult. to protest against the rates charged by the Metropolitan Telephone and Telegraph Company. It was decided to vote against those members of the Legislature who caused the defeat of the Bill to reduce telephone charges, which was introduced last year.

The Originator of the Telephone.—At the funeral of Antonio Meucci the Italian Consul made a short address, in which, after referring to the friendship between the deceased and Garibaldi, he claimed for Meucci the honour of being the first originator of the telephone.

Keighley.—The authorities will apply for a provisional order.

The Telegraphs in India.—All the telegraph lines in India, north of Lahore, have been placed under the direction of the Royal Engineers. They are worked by the men and their officers, under the assistant superintendent of telegraphs for that division.

An Electric Company for Ballymena.—Prominent townsmen are endeavouring to form a company for the supply of electricity. A scheme has been formulated which meets with general approval, and doubtless we shall soon hear that some genuine work has been accomplished.

Newcastle and the Law.—The legal point which has arisen in the lighting of Newcastle has been submitted to the legal advisers of the Crown, from whom an answer is expected at an early date.

Electric Illumination at Versailles.—The authorities have received several propositions for the establishment of public and private electric stations.

The Institution of Electrical Engineers.—On Thursday, 27th November, 1889, at the ordinary general meeting, Mr. G. L. Addenbrooke, Associate, will read a paper on "Electrical Engineering in America."

Electric Light Convention.—The American National Electric Light Association will hold its next convention in Kansas City in February, 1890.

Electrical Machinery for the Celestials.—The American Westinghouse Electric Light Company has secured a contract to erect a central station for a large electric light plant in Pekin, China. The town is to be lighted throughout with incandescent lamps.

Progress of Electric Traction in the States.—F. J. Sprague, of the Sprague Company, was recently in Chattanooga, Tenn. He said to a reporter: "I expect to see all cars in Chattanooga run by electricity in less than a year. Electricity, as applied to street railways, is making more rapid progress than any electric enterprise has ever done. Improvements and apparatus are being brought out very rapidly, and in the very near future the electric motor will be the most perfect piece of apparatus for the development of power ever created, and capable of more continuous and arduous duty. I was in Nashville a few days ago, and they intend to put up two lines. The South Nashville and the Nashville and Edgefield. They start with twenty cars, and are going to put in a station capacity for sixty, which show that they mean business. We have seventy-five or eighty roads in the country, and good prospects for an increase. Several roads have already increased double."—*Western Electrician.*

First Tunnel Lighted by Electricity.—Washington claims the honour of the first large railway tunnel to be lighted by electricity, this is the Stampede Pass tunnel on the Northern Pacific Railroad, which is 9,540 feet long, and is fitted up with a 600-light Edison municipal plant, using water-power, fed from melting snows from the mountain peak, for driving the dynamo.

The Use of Gas.—There is a Thomson-Houston exhibit at the Mechanics' Fair that shows well the saving when gas is used as a fuel instead of an illuminant. An Otto silent gas engine is used. During the evening's run at the fair, the gas engine working the Thomson-Houston electric plant consumes 300 cubic feet of gas, and furnishes 53 16-C.P. incandescent lights, while 53 16-C.P. gas lights, with 5-foot burners, would require 618 feet for the same length of time. This is a saving of over 50 per cent., and would, in a short time, pay for the first outlay of an electric plant, and the consumer would have the benefit of a brighter and more attractive light.—*Pacific Lumberman.*

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Montevideo Telephone Company, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 9th inst. The nominal capital is £220,000, divided into 29,000 preference and 15,000 ordinary shares of £5 each. The shares taken up are 27,000 preference and the whole of the ordinary, and the full amount has been called upon both classes of shares. The calls paid amount to £210,000. Registered office, 25, Abchurch Lane.

Devon and Cornwall Electricity Supply Company, Limited.—The statutory return of this company, made up to the 8th inst., was filed on the following day. The nominal capital is £100,000 in £5 shares. Only nine shares are at present taken up, and upon these no call has been made. The office of the company has not yet been registered, as required under the Companies Acts.

Scottish Automatic Supply Company, Limited (automatic, mechanical, and electric machines). The statutory return of this company is made up to the 1st July. The nominal capital is £12,500 in £1 shares. 8,507 shares are taken up, and of these 8,500 are considered as fully paid. Upon the remaining seven shares no call has been made. Registered office, 17, Devonshire Chambers, Bishopsgate.

Municipal Electric Light and Power Company, Limited.—The statutory return of this company, made up to the 2nd inst., was filed on the 9th inst. The nominal capital is £25,000, divided into 2,490 ordinary shares of £10 each, and 100 founders' shares of £1 each. The shares taken up are 37 ordinary and 30 founders' shares. Upon 30 ordinary and 30 founders' shares the full amount has been called, and upon 7 shares no call has been made; the calls paid amount to £120; and unpaid to £60. Registered office, 33, Old Broad Street.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.—The statutory return of this company, made up to the 18th October, was filed 23rd ult. The nominal capital is £120,000, divided into 15,000 priority shares, and 9,000 founders' shares of £5 each; the whole of the former and 3,000 of the latter are taken up, and the full amount has been called thereon; 6,000 founders' shares are also allotted as fully paid. The calls paid amount to £88,282, and unpaid to £1,718. Registered office, 20, Bucklersbury.

An agreement of 21st August (filed on the 5th inst.), between Woodhouse and Rawson, Limited (the vendors) and the company, provides for the allotment to the vendor of 6,000 fully paid shares in satisfaction of the obligation imposed on the company by an agreement of 4th June, under which the company acquires certain patent rights, &c., for £110,000, payable £80,000 in cash, and £30,000 by the issue of 6,000 fully paid founders' shares.

Fireless Motor Syndicate, Limited (mechanical and electrical engineers).—The statutory return of this company, made up to the 24th ult., was filed on the 30th ult. The nominal capital is £25,000 in £10 shares. 1,250 shares are taken up and are fully paid. Registered office, Crow Buildings, 18, Booth Street, Mosley Street, Manchester.

Electrical Purification Association, Limited.—The annual return of this company, made up to the 11th inst., was filed on the 14th inst. The nominal capital is £15,000, in £1 shares; 14,105 shares have been taken up, 5,000 being considered paid up. Upon 5,505 shares the full amount has been called, and upon 3,600 shares 4s. per share has been called. The calls paid amount to £6,005, and unpaid to £220. Registered office, 8, St. Martin's Place, Charing Cross.

Westminster Electric Supply Corporation, Limited.—At an extraordinary general meeting of this company, held at 2, Victoria Mansions, on the 11th ult., it was resolved that the capital be increased to £300,000. The resolution was confirmed on the 30th ult., and was duly filed on the 14th inst.

LEGAL.

The Queen v. Redman.—This was an appeal from the decision of a Divisional Court, consisting of Mr. Baron Huddleston and Mr. Justice Mathew. The London Electric Supply Company had erected at Deptford very large buildings, the eastern wall of which adjoined the premises of the General Steam Navigation Company. The buildings were completed in March, 1888, and in November, 1888, the General Steam Navigation Company discovered by digging that the wall had not proper footing as required by section 12 of the Metropolitan Building Act, 1855. Mr. Redman, the district surveyor for North-East Deptford, having refused to put in force the provisions of the Act, and to compel the London Electric Supply Company to comply with it, the General Steam Navigation Company obtained a mandamus to Mr. Redman to compel him to enforce the Act. From this Mr. Redman appealed. The Master of the Rolls said that the Court would not give judgment for a fortnight, and meanwhile the parties would do well to come to some arangement. It was impossible for them to say which way the Court would decide, and they would do well to take this course. Lord Justice Lindley thought it ought to be easy to come to some arrangement. Lord Justice Lopes entirely agreed in the suggestion.

CITY NOTES, REPORTS, MEETINGS, &c.

The Australasian Electric Light, Power and Storage Company, Limited.

WE have been furnished with the following report of proceedings at an extraordinary general meeting, held at the offices of the company, 39, Coleman Street, E.C., on Tuesday, 12th November, 1889. Mr. B. H. Van Tromp in the chair.

The Secretary having read the notice convening the meeting.

The Chairman said: Gentlemen, it will be within your recollection that when we met in July last you passed a resolution approving an agreement which we had then entered into with the Brush Company. I then told you I thought it highly probable that certain arrangements would have to be made which would render necessary an alteration in the terms of that agreement, and I fully prepared the shareholders for the possibility of our calling another meeting to make a statement as to the new arrangements so entered into. I may mention also that at that moment the Brush Company were in a condition of transition, acquiring not only powers to increase their capital, and powers to extend their operations by amalgamation with a manufacturing company, but to actually change themselves into a new company, and, therefore, we were advised by our solicitor, Mr. Ince, that for that reason alone, if for no other, it would be advisable to make a change in the arrangement. You will observe (as you have been already informed in the circular) that by the present arrangement we do not propose to hand over to the Brush Company the whole of the assets of this undertaking, but we agree to sell, and indeed have sold, subject to your approval, the patent rights and goodwill of the business in India and the Cape, Australia, and Australasia generally, and also the shares which this company holds in the Melbourne Company. We retain the whole of the other assets, comprising the plant in England, India, and Australia, book debts and various matters, including the balance of a call in course of payment. Under this arrangement, therefore, the Brush Company, under the name of the Brush Electrical Engineering Company, give us for the patent rights and the other assets I have mentioned £30,000 in their shares. These shares will be divided *pari passu* among the shareholders of this company. I may mention that the shares of the Brush Company are at a premium of 5s. to 10s. per share, so you will, I trust, be placed almost immediately in possession of assets which can be immediately realised and sold, if you desire to sell. It is evidence of the approval of the general body of shareholders in the Brush Company of the proposed amalgamation, and the general prospects, that the shares have risen to a premium since these arrangements were entered into. Consequently, the directors feel certain that you will have a proper value, realisable at any moment, and, therefore, having a great advantage over the shares which you have unfortunately held in this company for some years past, and which have not been saleable for some time, except at a large discount. We take it upon ourselves to realise the remaining assets. It is a condition of the agreement that we shall within a few months liquidate this company. We have made an arrangement with our purchasers that they themselves will provide the expenses of the liquidation, including the stamp duties on the transfers, &c., so that there will be no reduction on that account from the £30,000 in shares which you are to have. In addition to that we shall do the best we can when we go into liquidation, and the proceeds of the other assets we shall divide among the shareholders *pro rata* according to their holdings, so that we hope in addition to the shares which we shall hand over to you, to return you something in cash. There are one or two other points in the agreement. There is an option to the purchasing company to take over the assets which we do not assign to them now at the sum of £15,000. If they do not exercise that option, we are at liberty to realise these, and in that case we shall do the best we can. If we sell the plant, we shall offer it to them on the 1st February next at the same price as we should be willing to accept for the same from another party.

A resolution confirming the agreement between the companies was then carried unanimously.

A vote of thanks to the chairman terminated the proceedings.

Berlin Electrical Works.

Year July 1st, 1888, to June 30th, 1889.

THE annual general meeting of this company was held on October 26th last. It appeared that a nett profit of 383,609 marks had been realised. After paying over 5 per cent. of this sum, =18,963 marks to the reserve fund, as the German law demands a dividend of 8 per cent. on the three million marks share capital was declared, making 240,000 marks. A further sum of 15,000 marks was paid, according to agreement, to the municipal authorities. To the sinking fund were handed over 45,000 marks and 25,000 to the repairs fund. The original capital of three millions (marks) has been increased, but no dividend will be paid on this sum until the next season.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending November 15th, 1889, amounted to £5,204.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending November 15th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,714.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th November, are £1,841 as compared with £2,319 in the corresponding period of 1888. The July receipts estimated at £5,209 realised £5,225.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Continued from page 564.*)

THE selection of a suitable mechanical dynamometer was not easy. The following conditions were laid down as essential :—

1. It must be susceptible of a fair degree of accuracy, and show instantly any variation in the load.

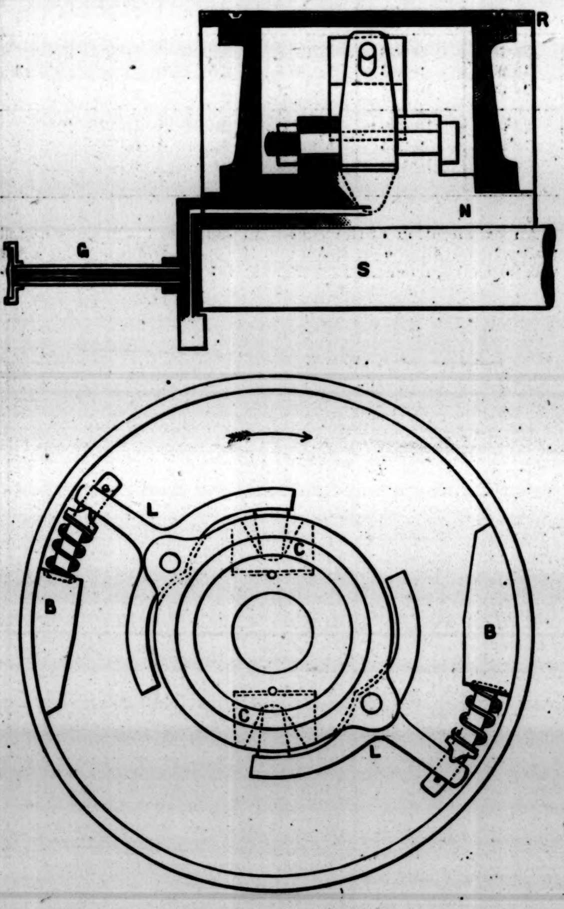
2. It should be of such a form that errors are not likely to arise from the difficulty (owing to the thickness of the belt) of accurately determining the virtual radius of the pulley; and no power should be absorbed between the point at which the pressure is measured and the dynamo spindle.

3. Any springs contained must be so placed that centrifugal force will not introduce uncertain effects on the indications of the instrument.

4. It must be portable, and easily fitted up.

The first condition simply requires that whatever the principle involved it shall be faithfully executed, and that the moment of inertia and number of moving parts shall be as small as possible. The second condition requires that the power shall be transmitted to the spindle of the dynamo at some fixed distance from its axis of rotation, and that it is the pressure at this point which is shown on the indicating mechanism.

The simplest way of fulfilling the above conditions seemed to be to give the dynamometer the form of a pulley to be directly applied to the spindle of the machine tested. It is important that the displacement of any of the parts of the mechanism shall be very small, even though the indicator passes from zero to its maximum reading.



S, shaft of dynamo; G, glass tube.

A pulley was accordingly constructed, the principle of which is as follows :—The energy supplied to the machine is transmitted through a fixed point at a distance intermediate between the axis of the spindle and rim of the pulley. By means of levers and pistons the pressure is transmitted to a fluid filling the chamber in which the piston moves, and by it through a glass tube which lies in the axis of rotation to a spring chamber, the capacity of which varies with the pressure on the enclosed fluid. The pressure on the point through which the energy is transmitted is shown by the displacement of the fluid in the glass tube.

The pulley (see diagram above) was made so that the rim, B, could turn freely on the nave, N. Two radial chambers, C, were carefully bored in the nave at the opposite ends of a diameter, and pistons were accurately fitted in them, so that though water-tight they could move freely. Two bent levers, L, were hinged at the nave, each being so shaped that when one arm pressed on the centre of the piston, the line passing through this point of contact and the centre of the hinge, was at right angles to the radius drawn through the point of contact. At the same time the other arms of the levers stood in a direction such that the surface of the lever remote from the piston coincided with the radius passing through the centre of the hinge. These arms were of such length that they just cleared the inner surface of the pulley rim. The connection between the rim and nave was made by means of two blocks of iron, B, riveted to the inner surface of the rim in such a position that they would come in contact with the projecting arms of the levers. The point of pressure was rendered definite by the use of knife edges, and any shock was relieved by the interposition of a suitable spring. Two small holes were drilled parallel to the eye of the pulley opening into the cylinders. The indicating apparatus was fixed so that it would coincide with the axis of rotation when the pulley was in use. It consisted of a glass tube, with a carefully fitted ebonite piston which served as a marker. This piston was made about 10 diameters long, and had several small grooves turned in it. The glass tube was mounted with a metallic chamber at each end, one being bolted to the pulley nave, the other closed with a circular corrugated steel spring similar to those used in some steam pressure gauges. The metallic chambers were mechanically connected by an iron tube in which three longitudinal slots were cut to enable the glass tube to be seen. The angular width of each slot was 60°. The scale was fastened on the inner side of the bars of the iron tube; consequently each time a slot turned towards the eye the glass tube and ebonite piston were seen projected on the scale that was fastened to the opposite bar. When in rapid motion the scale appeared as if drawn round the glass tube, and the end of the black ebonite piston formed a well-defined line from which to read. Every tenth division was marked in red, and the fifties were shown by a bright line on the outer surface of the iron tube.

In the pulley used the diameter of the bore in the glass tube was about $\frac{1}{25}$th of that of either piston. Hence, if both pistons were in use, the motion of the ebonite piston would be about 1,250 times as great as that of either of the main pistons. The length of the scale was about 6·5 inches, so that a motion of the main pistons of $\frac{1}{200}$th of an inch would cause the indicator to travel over the whole length of the scale. The pulley was arranged so that one or both pistons could be used. By this means the range of the instrument was doubled. Using one piston and running at 900 revolutions per minute, the maximum reading corresponded to about 30 horse-power, and with both pistons to about double that value.

It will be seen that a dynamometer of this form may be constructed to fulfil fairly well the conditions laid down as essential. The sensitiveness is determined by the stiffness of the steel spring and length of glass tube used. In practice a very great degree of sensitiveness is not required, as the variations in the power absorbed were found to exceed two, or at times even three per cent. of the total, whereas one-half per cent. could have been easily read. The ammeter showed fluctuations in the current at least equal in relative magnitude to those shown by this mechanical dynamometer.

To calibrate the dynamometer pulley it was keyed on a fixed horizontal spindle. A long balanced arm was bolted to the rim, and at a distance from the centre of the spindle (measured horizontally) equal to $\frac{20}{2\pi}$ feet a screw was put into the lever. Various weights were suspended from the screw, and the corresponding displacement of the ebonite piston noted. It was found that the displacement was directly proportional to the load; hence the scale could be so divided that the readings would show at a glance the tangential pull of the belt in pounds at any given radius. In the pulley used the constant was calculated for a radius of $\frac{10}{2\pi}$ feet. The reading showed at once the tangential pull at this radius, and, multiplying by ten, the number of foot-pounds absorbed per revolution of the armature.

It should be noted here that the levers in the pulley were counterbalanced for the centrifugal force of the pistons and fluid below them. The correctness of the balancing was tested by mounting the pulley on a spindle and rotating it rapidly in both directions, first of all having removed the rim. If the balancing were correct a small deflection should be produced, its direction depending on the direction of rotation, and the two deflections should be equal at the same speed of rotation. No error was detected, owing to the unequal distribution of the fluid pressure on the circular spring caused by centrifugal force. This fact is not surprising, when it is remembered that the effective diameter of the spring was only 1·25 inches, and that the fluid (glycerine) used was light.

The dynamometer pulley was placed on the machine which it was desired to test, in the daytime, and fresh glycerine put in. One of the bolts holding the field magnet core was taken out, and a similar one, but with a hole bored in it to receive the thermometer, put in its place.

The electro-dynamometers were always carefully adjusted for position after all machines were in full work, so that no disturbing effect would be introduced by the action of the current in leads which ran near the testing table. Each reading noted gave the mean position of the indicator for about 15 or 20 seconds in all measurements, whether electrical or mechanical.

The speed of the armatures was determined by one of Harding's counters, in all cases a full minute being taken.

The constants of all electrical instruments were calculated for the mean temperature of the dynamo room—27° centigrade. The temperature correction for the dynamometer pulley was not determined, as only the first or last two or three readings were to be used in the results, and the accuracy of these was ensured by taking the zero of the pulley both before and after the machine was run. The intermediate readings were taken only to show if any serious alterations took place in the general working of the machines.

These tests, the results of which are tabulated (see Table A), were made primarily to ascertain the commercial efficiency of the various arc machines used. By "commercial efficiency," I mean the ratio of the electrical energy available at the terminals to the actual energy absorbed at the spindle of the machine.

A.—EFFICIENCY OF BRUSH ARC DYNAMOS (No. 7L), HOT.

Description of Machine.					Mechanical Data.				Electrical Data.			Commercial efficiency.	
			Maker's Number.		Time of Run.		Revolutions per Minute.	H.P. absorbed at Pulley.	Current in ampères.	At Terminals.			Mean.
			Machine.	Armature.	Hrs.	Mins.				P.D. in volts.	E.H.P.	Per cent.	Per cent.
Solid Frame.	Armature Plates.	Thin.	457	N.T.A. 149	3	11	930	17·64	9·396	1,149·5	14·47	82	78·7
			924	N.T.A. 146	3	48	930	20·16	9·899	1,247·7	16·55	81·9	
			454	N.T.A. 143	3	24	935	21·43	9·705	1,234·9	16·07	74·9	
			460	157	3	0	930	22·89	10·1	1,220	16·52	72·17	
			462	...	3	0	930	19·95	9·731	1,261	16·46	82·56	
		Thick.	467	N.T.A. 184	3	35	930	23·34	9·861	1,232	16·28	69·75	69·75
Rail Pattern.	Armature Plates.	Thin.	1846	158	2	33	928·6	23·18	9·988	1,202·7	17·31	74·7	77·43
			1840	152	3	20	932	18·99	9·783	1,197 4	15·74	82·8	
			1849	161	3	20	930·6	24·66	10·001	1,376·9	18·45	74·81	
		Thick.	1843	N.T.A. 188	3	30	924·5	23·08	10·089	1,251·6	16·92	73·31	69·84
			1861	172	3	27	935	18 99	9·265	1,033	12·83	67·56	
			1856	167	3	0	917	26 8	10·129	1,350·6	18·34	68·65	

It will be seen that the current actually supplied by the majority of the machines was a little below the normal, the machines being professedly designed for a current of 10 ampères.

The times of run as shown in the table were not sufficient for the machines to attain their state of steady temperature, though in the majority of cases the temperature reached would be a fair average for ordinary working.

The armatures of the machines were interchangeable, so that any given armature cannot be considered a part of any specified machine; it was important, therefore, to ascertain not only the relative value of the different forms of frame, but also of the different armatures in them.

It will be seen from the table that the different forms of machine having thin-plate armatures are almost equally efficient, the solid frame pattern having a slight advantage. The difference, however, between the two forms of machine with thick-plate armatures is still less, and the advantage in favour of the rail pattern. But as only one of the solid-frame machines contained a thick-plate armature the comparison is of little value. For practical purposes it may be said that the commercial efficiency of the two forms of machine, provided the armatures are similar, is the same. Greater alterations in the efficiency of either class may be caused by slight alterations in the conditions of working, than the actual difference between the two classes as shown in the table.

The difference in the two types of armatures is very marked. Taking the mean from the two classes of machines, the efficiency of the thin-plate armatures will be found to be about 8·27 per cent. greater than that of the thick-plate armatures. But, unfortunately, the thin-plate armatures were not calculated to withstand the mechanical strains to which they are subjected in ordinary work, so the higher efficiency obtained from them has only a theoretical existence. There is, however, no mechanical reason why the armatures should not be constructed with thin plates, and at the same time be free from the mechanical faults shown to exist in those under review. Indeed, such armatures have been constructed in the Victorian railways telegraph workshops which are quite free from the faults named. One of these has been running for several years without ever giving trouble, and doing excellent work.

The curves in the diagram (fig. 1) were taken to ascertain the relative value of the magnetic circuits in the two classes of frames. The method adopted was as follows:—

The commutator brush-holders were electrically disconnected from the field magnet circuit. The ordinary brushes were taken out and replaced by others so bent that contact could be made with the commutator at the neutral point. The armature was run at the normal speed, and the field magnets were separately excited by a variable current taken from an incandescent circuit.

Simultaneous readings were taken of the current through the field coils, the potential difference at the terminals of the armature, and the speed of rotation. From these data curves were plotted as shown in the diagram.

All the machines tested in this manner had similar thin plate armatures. The resistance of the voltmeter used was great, so that the potential difference as shown by it was practically the electromotive force of the machine.

As the number of windings and speed of rotation of the armatures were the same, the electromotive forces would be directly proportional to the total induction through the armatures.

The induction through the armatures depends on the magnetising force, H, of the current in the field coils, and the goodness of the magnetic circuit.

In the machines tested the number of windings on the field coils were equal. Hence the electromotive forces of the different machines, when taken with the same current in the field, will represent the relative values of their magnetic circuits.

The curves may be taken either as saturation curves of the total magnetic circuit, or as curves of total induction through the armature, provided no sensible current is taken from it.

An examination of the curves in diagram 1 will show a small magnetic advantage in favour of the solid frames. This result was expected, from the fact that the bedplate increases the effective cross area of the field magnet yokes, but is not likely to materially increase the magnetic leakage owing to the great length of circuit.

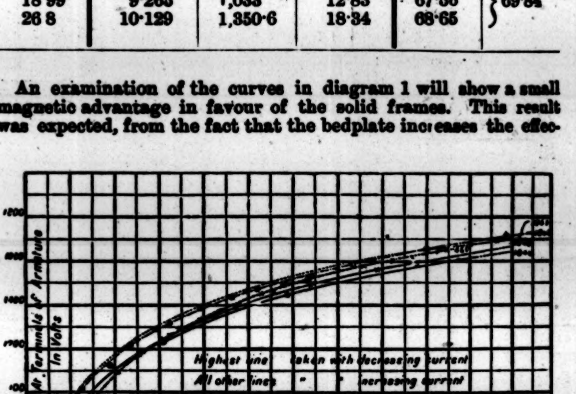


FIG. 1.

(*To be continued.*)

Physical Society, November 15th, 1889.

Prof. REINOLD, F.R.S., President, in the chair.

Prof. J. Milne and Lieut. G. F. Eyre were elected members.

Mr. ENRIGHT resumed the reading of his paper "On the electrification due to the contact of gases with liquids." Repeating his experiments with zinc and hydrochloric acid, the author by passing the gas into an insulated metallic vessel connected with the electrometer, proved that it was always charged with electricity of the opposite kind to that of the solution. The electrical phenomena of many other reactions have been investigated with the result that the gas whether H_1, CO_2, SO_3, SH_2 or Cl, is always electrified positively when escaping from acids, and negatively hen leaving a solution of the salt. In some cases distinct reversal not obtainable, but all these seem explicable by considering the lubility and power of diffusion of the resulting salts. Various her results given in the paper tend to confirm this hypothesis. eking for an explanation of the observed phenomena, the author uld arrive at no satisfactory one excepting "contact" between ses and liquids, and if this be the true explanation, he hoped to ove it directly by passing hydrogen through acid. In this, wever, he was unsuccessful owing, he believes, to the imposbility of bringing the gas into actual contact with the liquid. rue contact only seems possible when the gas is in the nascent ate. Some difficulty was experienced in obtaining non-electrified s, for the charge is retained several hours after its production, en if the gas be kept in metallic vessels connected to earth. uch vessels when recently filled form conductors in which the ectricity pervades an enclosed space, and whose charge is available on allowing the gas to escape. Soap bubbles blown with wly generated hydrogen were also found to act as condensers, e liquid of which, when broken, exhibited a negative charge. his fact, the author suggested, may explain the so-called "fireballs" sometimes seen during thunderstorms, for if by any normal distribution of heat, a quantity of electrified air becomes nclosed by a film of moisture, its movements and behaviour would losely resemble those of fire-balls. A similar explanation was roposed for the phenomenon mentioned in a recent number of *Nature*, where part of a thundercloud was seen to separate from he mass, descend to earth and rise again. The latter part of the aper describes methods of measuring the contact potential ifferences between gases and liquids, the most satisfactory of hich is a "water dropper," and by its means the P.D. between ydrogen and hydrochloric acid was found to be about 42 volts.

Prof. **RUCKER** asked if the experiment with zinc and hydrochloric acid could be started in the second stage by having the cid partly saturated with salt.

Dr. C. V. **BURTON** thought it probable that contact could be made etween a gas and a liquid by shaking them up together in a ottle.

In reply, Mr. **ENRIGHT** said the experiment could be started at ny stage, and reversal effected as often as desired by adding ither acid or a solution of salt to the generating vessel.

Mr. **HERBERT TOMLINSON**, F.R.S., read a paper "On the Effect f Repeated Heating and Cooling on the Electrical Resistance and emperature-coefficient of annealed Iron." In a paper recently resented to the Royal Society, the author has brought forward n instance of an iron wire which, when subjected to magnetic ycles of minute range alternately at 17° and 100° C., had its olecular friction and magnetic permeability reduced respectively o about one-quarter and one-half their original values. The resent experiments were undertaken to see whether by such eatings and coolings, the temperature coefficient of iron could be rought down to something approaching the number given by Matthiessen for "most pure metals." The wire experimented on was first annealed by heating to 1,000° C. for several hours and allowing to cool slowly in a furnace placed at right angles to the magnetic meridian; the process was repeated three times. Afterwards the wire was covered with paper and wound doubly into a coil. This coil was enclosed in a water-jacketed air chamber and connected with a sensitive Wheatstone bridge. Thermo-electric and Peltier effects were eliminated by always keeping the galvanometer circuit closed. By repeated heating to 100° C. and cooling to 17° C. for long intervals, the specific resistance at 17° C. was reduced from 11,162 to 10,688 C.G.S. units, after which the operations produced no further change. At the same time the temperature coefficient increased in the proportion of 1 : 1·024 From careful determinations of the resistance at different temperatures the formula

$$R_t = R_o (1 + \cdot 005131\, t + \cdot 00000815\, t^2)$$

was deduced, whilst that obtained from Mathiessen's results for pure iron annealed in hydrogen is

$$R_t = R_o (1 + \cdot 005425\, t + \cdot 0000083\, t^2).$$

Taking his own determination of specific resistance of impure iron as correct, coupled with Matthiessen's law connecting the resistances and temperature coefficients of metals and their alloys, the author finds that the specific resistance of pure iron deduced from Matthiessen's results is from 4 to 5 per cent. too high.

In conclusion, Mr. Tomlinson expresses a hope that the B.A. Electrical Standards Committee may be induced to determine the absolute resistance and temperature coefficient of the pure metals which are in ordinary use.

Prof. **AYRTON** thought Matthiessen's results were expressed in B.A. units, and hence might appear 1 or 2 per cent. too great. Mr. Tomlinson, however, believed the number he took were expressed in legal ohms.

Dr. **WALMSLEY** asked for what value of the magnetising force the permeability of the iron mentioned in the beginning of the paper was determined; to which Mr. Tomlinson replied that they were much smaller than the earth's horizontal component.

Dr. Thompson's paper on Geometrical Optics was postponed.

City Guilds Old Students Association.

"Some Peculiarities of Alternate Currents." By W. E. SUMPNER, D.Sc. Presidential Address, read at the Central Institution, November 19th, 1889.

Alternating currents are not by any means new, although it is only lately that they have become of great importance in engineering work. The dynamos first made yielded alternating currents, because as they needed no commutator they were simpler to construct. They were not adopted, partly because continuous currents were easier to understand and to use, and partly because direct current dynamos could be made self-exciting. Alternators came to be looked upon as antique types which had yielded place to the more perfect direct current machines. However, the currents used outside the dynamo, although direct, were, of course, the result of rectifying, by means of a commutator, the alternating currents produced in the armature by its own revolutions. All dynamos, therefore, produce alternating currents in the first instance, and in the same way all motors, before they will work at all, must be fed with alternating currents, whether a commutator is introduced to produce these alternations or not. The action of all machines used for the production of currents depends on the properties of magnetic change discovered by Faraday. The currents induced depend on the rate at which the magnetism varies, and alter in direction as it increases or diminishes. The magnetism cannot always be changing in the same direction, so that the currents induced must be alternating. Nearly all the useful appliances of magnetism result not so much from magnetism itself as from the alternation of it. This is the case, for instance, in telegraphy and telephony, in which we are always using varying or alternate current. If I pass an alternate current through one of the coils of this transformer we hear it singing. The current in the coil induces magnetism in the iron, and this changes in direction every time the current alternates. The magnetism acts on the windings of the coil, causing attractions which vary in amount with the strength of current; and it also causes in the iron itself stresses and strains which alter it every reversal of current. Vibrations are therefore set up which give rise to a note of a pitch corresponding with the frequency of the current. If due to any irregularities in driving or want of symmetry in the dynamo, the strength or frequency of the current is subject to variation, the note given out by the transformer will indicate this by altering its strength and pitch. The consequence is that the sound given out is very similar to the hum of the engine and dynamo. The transformer acts like a telephone; and, indeed, in principle a telephone is nothing more.

The first difficulty in connection with alternating currents is to settle how to measure them. They are continually varying, and therefore cannot be said to have any value in particular. If I pass the varying current produced by this commutator through an incandescent lamp you notice that when I turn the handle slowly the lamp varies in brightness as the strength of the current changes. If, however, I turn the handle quickly so as to produce twenty or more alternations per second the lamp burns quite steadily. The strength of the direct current which would make the lamp burn equally well is said to be the mean value of the alternating current used. This definition seems simple enough, but it defines the value of a current with reference to its heating effect only. It is soon realised that the importance of an alternating current depends chiefly on its magnetic influences, and not to any great extent on its heating effect. With steady currents the two are proportional, and each, therefore, is a measure of the other. Partly due to this cause, and partly due to the false notion that the current carries energy along with it, we are liable to confuse the heating effect of a current, which represents waste energy, with the useful energy of the current, which has no necessary connection with it, and in consequence some of the properties of alternating currents seem at first surprising. The efficiency and life of lamps seem to depend merely on the mean heating effect, for, as far as we know, they are the same for direct and alternating currents in spite of the fact that with the latter the maximum value of the current is far in excess of the mean value. With most of the practical applications of alternate currents, however, we have to bear in mind not only the strength of the currents, but also their frequency and magnetic surroundings. The currents and potentials are continually rising and falling in value. They are really waves, and have all the properties of waves.

Now one of the chief peculiarities about waves is that they do not add together in the same way that numbers do. They add together like forces. We all know that if two forces, each of one pound, are acting on a body, the effect is not the same as that of two pounds, unless the two forces act in the same direction. According to the angle between the forces the force equivalent to the two may vary from two pounds to nothing. If two men are pulling at the same rope in order to ring a church bell, it is necessary for them to pull together, or one will tend to stop the bell while the other is trying to ring it. In the same way two waves flowing to the same point will add to each other's effect if their rising and falling occur at the same time, but otherwise they will interfere and diminish each other's effect so that the resultant disturbance may be less than that which either would have caused separately. It does not, therefore, follow that two alternating currents flowing into the same wire will produce a current whose strength is the sum of the strengths of the two components, and, as Lord Rayleigh[*] has pointed out, if a current branches into two parts by means of two parallel circuits it may happen that each of the branch currents is greater than the original current.

I have here the primary and secondary circuits of a Mordey transformer connected in parallel in such a way that if steady currents were flowing the coils would magnetise the iron in the same direction. In the main circuit, and also in each of the branch circuits, a Bernstein lamp is placed. When I close the circuit you notice one lamp is much brighter than the others, and the brightest lamp is in the branch circuit, not in the main; if I now disconnect one of the branch circuits, the current diminishes to practically nothing, although the potential on the remaining coil actually increases. Shunting one coil with the other therefore not only increases the main current but also that in the part shunted. These effects of course do not occur with steady currents.

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[*] See *Phil. Mag.*, May, 1886, p. 378; and also December, 1888, p. 495.

A somewhat similar experiment is due to Mr. Blakesley. His branch circuits consist, one of a resistance possessing self-induction, and the other of a condenser. By suitably choosing the capacity of the condenser it is possible to increase the current through the self-induction branch, and make it exceed the current in the main circuit. Mr. Blakesley calls his arrangement a condenser transformer, and it seems to have important practical bearings.

The following experiment is due to Mr. E. W. Smith of the Central Institution:—It is analogous to Lord Rayleigh's potentials being dealt with instead of currents. Here is a coil having a fairly large amount of self-induction in series with an inductionless resistance. Here are two similar lamps of large resistance shunted, one to the inductive and the other to the non-inductive resistance. I pass the alternating current through the arrangement, and adjust the resistance till the lamps are equally bright. Each lamp now measures the difference of potential of the points to which it is shunted. I now remove the wire which connects the junction of the two lamps with the junction of the inductive and non-inductive portions. You notice that each lamp diminishes in brightness, showing that the whole potential difference is less than the sum of the two halves. By making the shunt connection again each lamp brightens up, although Mr, Smith's experiments have shown, and theory confirms the fact, that the main current from the dynamo is diminished by so doing. By making the shunt connection we necessarily diminish the resistance, although the potentials appear to increase and the main current to diminish, quite the opposite of what would occur with steady currents.

I have extended this experiment by forming a Wheatstone's bridge, two opposite arms of which consist of inductive resistances, the remaining arms being non-inductive. To each corner of the bridge I have attached a flexible lead coming to these lamps. The two wires attached to the corners of the bridge connected with the dynamo I have labelled red, and the remaining two, joining the parts of the bridge usually attached to the galvanometer, are labelled white. I connect the red wires to the terminals of the two lamps, the junction of which I connect successively with the white wires, adjusting in each case the corresponding non-inductive resistance till the lamps are equally bright. Each time I make connection with the white wire the lamps brighten as before. From analogy with steady currents we should now expect the bridge to be balanced, since the potential difference between either red and either white wire is the same. This, however, is not at all the case, for if I join the white wires to the extremities of the two lamps we notice they burn almost as brightly as when joined to the red wires connected directly with the dynamo. Theory indicates that if the impedance of the inductive arm were large, compared with its resistance, the potential between the white wires would be exactly equal to the potential between the red ones, and that in any case, if the bridge is balanced in the way described, there will be a difference in phase between the two potentials corresponding with a quarter of a period, so that one potential difference will reach its maximum when the other is at zero.

Now this is exactly the difference in phase required to drive a Tesla motor. I have here a small anchor ring of iron wound with coils in four quadrants. The coils in opposite quadrants are connected in series, so that a steady current flowing through either pair will cause a north and south pole in the adjacent quadrants. If, now, alternating currents, differing in phase by a quarter of a period, are sent through the two coils, each pole will move from one quadrant to the next every quarter of a period, so that the polarity will revolve round the ring with the same frequency as that of the alternating current. There is an iron disc free to revolve about the axis of the ring, and when I connect the red wires with one pair of coils, and the white wires with the other, you see the disc spins round at a great velocity, and thus forms a Tesla motor. There is, however, this peculiarity about it, that only one alternating current is used. The disadvantage of a Tesla motor is that it requires two alternating currents fixed in phase with reference to each other, so that it is necessary to have a special dynamo to produce the currents, and also to have at least three leads instead of two; here, however, is a method of making any alternate current work a Tesla motor. Mr. Blakesley* has, I find, already suggested his condenser transformer for the same purpose. The method I have suggested is not economical, but it can be improved by having the arms of the bridge of high resistance of impedance, and having two opposite quadrants of the Tesla field magnets wound with many turns of fine wire, instead of a few turns of thick wire. Moreover, if condensers of suitable capacity are substituted for the non-inductive arms of the bridge, the waste will be smaller, and the amplitude of the potential between the white wires will actually be greater than that between the red ones attached to the dynamo. At all events, there seems to be fair ground for supposing that some such arrangement can be found by means of which a Tesla motor can be economically worked off any alternating current.

Striking effects of interference are obtained by putting a coil, whose impedance is large compared with its resistance, in series with a condenser of suitable capacity. If an alternating current is passed through such an arrangement, and measurements of potential are made with a quadrant electrometer used idiostatically, the potentials at the terminals of the coil or condenser are each found to far exceed the potential at the ends of the combination. Theory indicates that under the most favourable conditions, the two former are equal to each other, and the ratio of either to the latter is then approximately equal to the ratio of the impedance of the coil to its resistance, when this ratio is fairly large.

Thus, with the secondary of an induction coil having a resistance of 6,000 ohms, and co-efficient of self-induction of 50 quadrants or secohms, and with a condenser of 0·05 microfarads capacity, calculation shows that the most favourable frequency of current to employ would be 98 periods per second, and that the potentials on the coil and condenser would then be each about five times the potentials on the two in series. In the confirmation of this by actual experiment I have had the advantage of the assistance of Messrs. Monckton, Simon, and Taylor, of the Central Institution. The field magnets of an alternator were excited with suitable currents, so as to produce at varying speeds of the dynamo an alternating potential of about 30 volts. In the annexed table the results obtained are recorded. The number of periods per second corresponding with the speed of the dynamo is indicated in the first column: the second column gives the ratio of the potential on the induction coil to that of the dynamo, and, of course, is equal to the square root of the ratio of the corresponding deflections: the third column gives the ratio of the potential on the condenser to that of the dynamo: the last column gives the sum of these two ratios, which, but for interference, would always be unity:—

Periods per second.	Potential on coil.	Potential on Condenser.	Sum of Potentials.
73	1·00	1·93	2·93
82·5	1·84	2·64	4·48
102	4·38	4·14	8·52
116	3·28	2·49	5·77
120	2·91	2·06	4·97

From these numbers it is evident that the potentials on the coil and condenser will be equal when the frequency is less than 102 periods per second, and that the sum of the two potentials will be greater than 8·52 times the potential of the dynamo. When it is considered that the self-induction of the coil, which had an iron core, was measured, not with rapidly alternating currents, but with a single impulsive change of current, the agreement between the theory and experiment is quite satisfactory. but although theory so perfectly accounts for the effects, it is nevertheless surprising that a difference of potential can be divided into two parts, each of which is so much greater than itself. Of course, if 20 accumulators are connected up in series with 19 others, and in opposition the potential on the whole is two volts, while those of the parts are 40 and 38 respectively, this tends to prove, what is practically true, that the alternating potentials are in opposite phase; but the peculiarity with alternating currents is that the potentials of the two parts may be exactly equal, while that of the whole is neither the sum of the two nor the zero difference.

What is really happening in these cases of interference is illustrated by an experiment on pulsations which I am able to perform by means of an ingeniously contrived commutator kindly lent me by Mr. H. B. Bourne. Alternate bars of the commutator are connected together and to the two ends of a battery of cells. There are two brushes, one fixed and the other movable, so that as the commutator revolves one brush may be made to move over the bars more rapidly than the other. Each of these brushes is connected with the middle of the battery through the primary of a transformer. As the commutator revolves an alternating current comes off from each brush. The period will be the same if the brushes are both fixed, and the phase may be altered by moving one brush with reference to the other. If one brush revolves slowly the two alternating currents are of slightly different period. The two secondaries of the transformers are connected in series with themselves and with an incandescent lamp. The brightness of the lamp measures the sum of the two currents induced in the secondaries by the alternating currents in the primaries. If the currents coincide in phase the lamp burns brightly, while if the phase of the currents is opposite, as I can arrange by suitably fixing the movable brush, the lamp is extinguished. If I now move the movable brush slowly, the phase of the currents is continually altering, and you see the lamp slowly pulsating in brightness. Although the two alternating currents induced in the secondaries are always of the same strength, yet their sum varies from zero to double the value of each, according to the phase of one with respect to the other.

After all, however, the most extraordinary property of alternating currents is that which has been longest known, viz., their tendency to transfer themselves from one circuit to another with which they have apparently no connection. The appearance of these induced currents is accompanied, not by a decrease, but by an increase of the primary. The primary and secondary currents increase together. The explanation is that the currents are in nearly opposite phase, and one current is neutralising the magtising effect of the other. The magnetism caused by alternating rrents always tends to a minimum, and the currents have to range themselves so that their joint magnetising effect may be small as possible. This tendency is very marked at high speeds, d the compensation is almost perfect. The little magnetism reaining is, however, very important, because of its extremely pid rate of variation. The induced electromotive forces depend this rate of variation and not on the maximum amount of magtism. Thus in transformers there is a strong tendency for the imary and secondary currents to be in opposite phase.

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* See the discussion on Mr. Kapp's paper on "Alternate Current Machinery." Proc. Inst. Civil Eng., February, 1889.

This is the explanation of a simple but important experiment e to Mr. Mordey, and the fact was proved by a large number of periments made by Messrs. C. G. Lamb and E. W. Smith at this ollege some time ago.*

The strengths of the currents in the coils also arrange themlves to be nearly in inverse proportion to the number of turns, for is is the condition under which the magnetising effects should be qual. There is also a tendency for the magnetism to alter itself the simplest way possible, and this is according to the law of nes. The secondary currents, therefore, tend to follow the law sines, because they exactly follow the variations of the magetism. The primary current will also follow the law of sines if e magnetism is proportional to the current, but if saturation is pproached, calculations which I have made from experimental ata show that the primary current may depart very much from a imple sine wave, as will also be the case if the electromotive force cting on the primary is itself irregular.

The tendency of magnetic change to a minimum is exemplified the action of choking coils, and in the heating of iron cores. If n opposite current can be induced in neighbouring circuits or odies so as to cancel the magnetising effect, the primary current allowed to flow, but otherwise the reluctance of the magnetism o change suddenly will prevent the current rising to any magitude.

The same tendency occurs within the wire itself, for the adjacent ortions of the current tend to flow in opposite directions. The endency to reverse currents is strongest in the centre of the wire, nd consequently the current density is less there than near the urface. The resistance of the conductor is increased by this, and he alteration is very important when the wires are thick and the lternations of the current are very frequent, as, for instance, in the hick wire circuit of electric welders. Thick leads are, therefore, ot well suited to alternating currents, but, on the other hand, hey are rarely necessary, for by means of transformers large amounts of energy can be efficiently transmitted immense distances by means of inexpensive thin wires.

It is not, however, only in engineering practice that alternate currents have become of great importance. Within the last year or so the theory of electricity has been advanced tremendously by the study of alternating currents. We have seen that with rapid alternations the currents are determined chiefly by the magnetic changes which are going on, and that they arrange themselves as far as possible to neutralise each others magnetic effect without much apparent regard to the electromotive forces acting on the resistances in circuit. This tends to show that the most important part of an electric current is not in the wire itself, but in the region outside. It has been, by considering the changes going on in the medium outside the wire, that Hertz has been able to experimentally prove the existence of effects which have hitherto only had a mathematical basis. If a current is reversed in direction, the lines of force surrounding it are also reversed. Maxwell's theory, however, states that they do not reverse instantly. The lines of force near the wire reverse before the others. There is a certain velocity at which the reversal of the lines travels, and this velocity, according to theory, should be about the same as the velocity of light. That this is actually the case is one of the things which Herts has lately shown. In order to do so, he has made use of rapidly alternating currents. He has also employed a detector, whose great delicacy is due to the principle of resonance, which may be illustrated by an experiment of Prof. Ayrton's which I have arranged. An alternating current is passing along this stretched wire. When I hold a magnet near, the wire is pulled aside, due to the mutual action of the current and the magnet's lines of force. Every time the current reverses, the direction of the pull on the wire reverses, so that the wire is put into a state of vibration. The loudness of the sound, however, depends on the length of the stretched portion of the wire. There is one length which will give the best effect, and this happens when the wire is tuned to give out a note of the same pitch as that corresponding with the frequency of the alternating current. The current, in any case, forces the wire to give out a particular note; but if the wire naturally gives out that note, the sound produced is much greater. The interference of potentials occurring when an induction coil is placed in series with a condenser, is another instance of resonance, for the condition that the potential on the coil should be greatest compared with the whole potential acting on coil and condenser, can also be shown to be the condition that the natural period of oscillatory discharge of the condenser into the coil coincides with the period of the alternating current. It has been by using the principle of resonance that Hertz has been able to detect, in the medium outside the wire, cases of interference with magnetic reversals exactly similar to those I have shown you with alternating currents and potentials. His work has opened up an endless field of discovery, and these results have been brought about by making use of the peculiarities of alternating currents.

THE PROPOSED ELECTRIC CITY RAILWAY.

OPPOSITION OF THE SEWERS COMMISSION.

ON Tuesday, at the meeting of the City Commissioners of Sewers at the Guildhall (Mr. GEORGE MANNERS in the chair), a letter was read from Messrs. Ashurst, Morris, Crisp & Co., the solicitors to the Bill for the proposed Central London Railway. The Bill provides for making a western terminus of the railway at Queen's Road, Bayswater, and for carrying the line along the Bayswater Road, Oxford Street, Holborn, Newgate Street, Cheapside and King William Street, making a junction with the City and Southwark subway, near Arthur Street West. There will be stations in the vicinity of the Marble Arch, Holborn Circus, the General Post Office and the Royal Exchange. The line is intended to be both lighted and worked by electricity. The letter from Messrs. Ashurst & Co. asked for instructions as to posting street notices regarding the proposed railway.

Mr. WOOD moved, "That the Commissioners of Sewers do take steps to oppose the proposed Bill for the construction of the railway."

The CLERK stated that the only notice he had received was a communication asking how notices were to be posted.

Mr. WOOD thought this an indication of how the promoters of this railway proposed dealing with the citizens. On Saturday his attention was directed to the fact that there were hanging to the lamp posts along Cheapside notices of an intention to apply to Parliament for the construction of a central London railway. He was referred by the company's solicitor to advertisements which were about to appear, and he found the clerk of the Commission had not received one of the notices which had been hanging on the lamp posts under their control. He did not hesitate to say that the project was one of the most momentous character. The railway proposed to pass from Marble Arch, down Oxford Street, Holborn, Newgate Street, Cheapside and Poultry. It would dislocate the traffic through the whole line of those thoroughfares, and inflict untold loss upon the traders. They remembered what they had suffered during the construction of the Metropolitan and District Railways, when whole thoroughfares were enclosed by hoardings, hundreds of carts were engaged removing the soil, the foundations of houses were insecure, and traders were grievously injured. The proposed electric railway would be a still more serious affair. The company proposed to obtain for nothing the whole of the ground under the roadway, which was public property, and to protect themselves against giving compensation to those whose interests might be damaged. The only advantage they offered the public was to travel through their stinking hole at the peril of their lives and certain injury to their health. (Laughter.) The scheme was a great Stock Exchange gamble—the traders and citizens were to be the markers in the game, and poor shareholders would suffer irretrievable loss. He hoped the Commission would leave no stone unturned to defeat this most mischievous of projects.

Mr. J. C. BELL said he would second the resolution if the mover would amend it and refer the matter to committee. They could hardly imagine the chaos which would prevail, and possibly total ruin would ensue, to the traders along the line of route.

Mr. WOOD consented to alter his resolution as suggested.

Mr. PRICE thought the scheme of this electric railway was altogether premature. They should, first of all, ascertain what powers the company were seeking to obtain. By December 15th notices would have to be served on all interested, and afterwards the company would have to lodge their plans. Then they would be able to judge fairly about the matter. He did not suppose they would cut and cover as in Cannon Street, but let houses down in their route, which was mischievous enough

The CLERK stated that the company had taken it upon themselves to put the notices on the lamp posts. The Commission had never advised them what to do.

Alderman Sir W. LAWRENCE considered this a most important matter and one that required most careful and serious consideration. He would support the suggestion that the matter go to the Streets Committee for consideration and report. It was a subject that might well be discussed at the wardmotes on St. Thomas's Day. It had numerous bearings and wide issues. If such a railway would be beneficial to the City, then, after due consideration, they should support it. If, on the contrary, they should come to the conclusion that such a thing should not be allowed—as he believed they would—then they could make their opposition all the more powerfully felt when it was known that they had thoroughly threshed out the subject in all its bearings. He thought Mr. Wood was entitled to their thanks for making known the course of procedure.

Mr. DEPUTY WALTER thought the officers of the Commission ought to have torn the placards down.

Mr. SLY contended that at present the Commission were not in a position to understand the matter, and they ought not to take action before they were in possession of the facts.

Ultimately the court referred the matter to the Streets Committee.

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* See discussion on Mr. Kapp's paper on "Alternate Current Transformers," Journal Society Telegraph Engineers, February 23rd, 1888; see also a note of Profs. Ayrton and Perry, on "The Lag in Transformers," in the *Electrician* for March 16th, 1888.

INNOCENTS ABROAD.

DURING a discussion at a recent meeting of the American Institute of Electrical Engineers on Mr. Lockwood's paper, "Electrical Notes of a Transatlantic Trip," an English electrician who is well known to the readers of the ELECTRICAL REVIEW, relieved his high tension feelings as follows:—

Mr. G. L. ADDENBROOKE: I should be only too glad to say anything that I can, premising my remarks with the statement that I have been away from England very nearly a year, chiefly in Australia, and that I came here to find out what they have been doing in England. I rather came here to hear the latest news than to be able to say anything myself. It is a great pleasure to have heard Mr. Lockwood speak so appreciatively of the overhead work in England. We have felt satisfied, ourselves, that our overhead work has had a good many defects in it, but we look in England a great deal to people in America, and Mr. Lockwood having such thorough experience, and speaking so well of what we have accomplished, it gives us a great deal of gratification, especially as I happen to have been connected with the work in various capacities myself, both telephonic and electric lighting. In referring to overhead electric light work I am speaking rather of the past than of the future, because I think you are aware the commission appointed by the Board of Trade which has lately gone into the whole matter, has formed a set of regulations under which the whole of the electric lighting in London is to be placed underground as soon as possible. No further overhead wires are allowed to be placed, except such as may be agreed upon between the inspectors of the various companies, and the central station companies in London are now very hard at work laying down mains. However, there is no doubt a good deal of overhead work will be required for various purposes, and as you have so much overhead work here perhaps it might be worth while to explain our practice. First of all, we have not been allowed to plant posts in the streets at all, except in country roads. Within the boundaries of towns it is an absolute rule that no posts can be fixed in the streets. If we want posts we must put them in people's back gardens and in vacant lots, &c. Of course, this has necessitated that the majority of posts be placed on the tops of the houses. In foreign towns they have also had to go on the tops of the houses very largely. They have adopted one construction, we have adopted another. On the Continent most of the roofs have a very steep slope, and are tiled so that it is quite impossible to walk on them, and, of course, people do not put up stronger roofs than they can help--only strong enough to support the tiles and stand the wind, but not strong enough to support telephone posts. On the Continent, they use two long pieces of timber and form what they call a horse. That consists of a number of uprights and a lot of cross frames. I think you have some of them here. Nearly the whole of the work is done in that way, and I may mention that I happened to be with one of your countrymen, Mr. Wells, in Antwerp, and he also told me that any stray cats the linemen found there were always put in their tool bag and were eaten at home afterwards. In England we went to work in quite a different way. As Mr. Lockwood said, it is not unusual in London, at any rate, in overhead work on houses, to have wires arranged horizontally.

As a rule, there is but a single span. We have, first of all, what we call a chair. That is an iron casting weighing from 50 to 60 lbs., that goes on the top of the roof. From this rises a wrought iron tubular pole. Those tubes are carefully made to specification; they are about 3 inches internal diameter. It is usual to put up a pole of not less than 18 feet, but they range as high as 30. In the case of a pole 30 feet high, it is usual to have two or three poles, one inside the other, each pole having a collar and a bolt going through. These poles are simply stayed to the brick work. Heavy spikes are driven in the brick work. It is rather an agonising process for the house as you may imagine, but still somehow men have a way of doing it, and they drive spikes 8 inches long into the brick work. It is wonderful how the brick work stands it. I must say that I have seen some very large cracks occasionally. The wall itself will split out in the plaster occasionally. Each pole will have at least four of those stays under ordinary circumstances, and then, of course, it has to be stayed in accordance with the rules. When I came to America and saw the mass of wires running in all directions, it reminded me of what we call the early days of telephones in London, and we had so many faults with wires then that I could not understand how things worked here. So I looked about me and I find, apparently, the difference is that we think nothing of a span of 120 yards. Sometimes in telephone work we go 200 yards, and 150 yards is considered very little for a span of wires. Of course, in running wires that distance there is a very considerable amount of saving, and in a wind they are liable to come in contact with each other, and they are also apt to get out of regulation—that is, wires put in when the weather is hot, and wires put in when it is cold, and brought into unison, will get out of unison occasionally. So that perhaps accounts for the reason why you are able to run such a mass of wires about the streets and yet get along at all. When we had a rival in the Globe Telephone Company, we had a high old time in getting at each others "wayleaves." In putting up a pole 25 feet high and running wires from top to bottom, it is hard to get wires across in that vicinity. We went on for about two months. If they were running a route here, we would run one across there. We got the two highest houses we could and blocked them, and they did the same to us. Of course it ended as most of those things do. The United Telephone Company bought the other company out, and most of the wires were afterwards taken down. Then we come to another point, what we call "leading in"—that is, taking the wire from the pole to the office of the subscriber. In England that is always done with gutta-percha covered wire. The people who began the telephone work in England were those who had had a little to do with telegraphs. This wire costs about three or four pence a yard. It has a thick covering of first-class gutta-percha. Of course this insures immunity from faults and leakage, and it is in some cases taped, and in some cases braided. But if it is taped, it is very strongly taped, and the whole thing is what you call a very excellent job.

One very great reason why tramways perhaps have not made more advance in England is that posts are not allowed in the streets. Probably in the country districts they might be allowed, but without a lot of formalities, &c., before town councils, no leave to put up posts will be given. I think it is highly probable it will come, but still it will take time. On the other hand, notwithstanding what has been said about electric railways here—I know perfectly well you have nearly a thousand miles in operation—I have just come from San Francisco; I stopped in San Francisco some days; I stopped at Denver and Salt Lake City and at Chicago and at Pittsburgh and at Philadelphia, and I have been here some days. At each of these places I have done all I could to see electric tramway work. I happened to see a car in the distance at Salt Lake City. They were putting up the wires in Pittsburgh. I was kindly shown a car running with accumulators here yesterday. I called on the Sprague Company and they said they had nothing which they could show within a hundred miles of New York, so that although you have a great deal, yet your country is so large, and the work so scattered about, that it does not show much, and I think, perhaps, the same applies to England. We certainly haven't got anything like that length of track, but there are a lot of little tramways running about there which I think may be called to some extent the pioneers of tramway work. For instance, there is the Blackpool tramway which has been running for several years. There is the Port Rush tramway in the north of Ireland, which I think was the first electrical tramway ever erected. There is a small tramway running along the Brighton Beach which has made things very popular. That has been running six years. There are two or three companies in England operating experimental lines now in a small way, and certainly without going out of your way to see them you probably would not succeed in doing so. I had thought that perhaps Mr. Lockwood would have seen the new underground railway which runs from the Monument in the city to the Elephant and Castle, about three miles distant on the other side of the river. That is one of the most interesting engineering works which has lately been accomplished in England.

You all know something about the underground railway, which corresponds to your overhead railway here. Your elevated railway is certainly very efficient and very cheap. Ours is very expensive, and some people say very nasty, but it answers its purpose and you don't see anything of it. Well, the new underground railway in London starts from the Monument and goes right under the bed of the river at about 20 feet depth, and so far under the foundations of any houses that it has not been found necessary to compensate the owners. It goes about 60 feet under the houses. At the Monument there is a station with hydraulic lifts. I am not aware whether it is actually running or not, but it is nearly finished, if not quite so. At each station there is a series of lifts, by which the passengers go down or come up. From these two tunnels are driven through the ground starting away to the other end of the line. This railway is going to be operated by electricity. The firm of Mather & Platt, of Manchester, undertook to furnish the whole of the electrical plant and run it for a term of years at a price which I believe—at least I take this statement from the paper—was considerably less than what it would cost the underground companies to work their locomotives by steam, and as Mather & Platt are a very large concern—who, by the way, make the Edison dynamos in England, as well as the Manchester—no doubt they are prepared to stand the racket if it does not succeed. But I think that will be a very interesting application. By the way, Edward Hopkinson is their electrician. He is a brother of John Hopkinson.

Passing on to electric lighting, beginning at the station, at the Grosvenor, we were working with 2,500 volts; and the dynamos were so perfectly self-regulating, at any rate when I was there, and with the load they had on them, that all regulating appliances were practically unnecessary beyond a sensitive governor on the engine and perhaps an electric governor on the engine and something to keep the exciter in order. All you have got to do is to keep your dynamo turning round at the same rate. The circuits were so large that the putting on of lights or taking them off practically made no difference, and we always arranged things in this way, that we never allowed, if we could help it at any rate, any large circuits to be run in public buildings or theatres, or anything like that. That is to say, we always contrived that not more than 50 or 60 lamps should be turned off at the same time. Of course a man going around a building could turn off four or five switches, but while he was doing that the engine driver would have a chance to look around. The circuits were so large that 50 or 60 lights on or off practically made no difference, and most of the regulation was simply done by the engine driver standing near his engine when the curve was going up like that. Of course that simplified matters very much.

The overhead work is done on very much the same line as telephone work, only the poles are shorter, sometimes they are not more than 12 feet, but as a rule they run to 18 feet. Near the f the pole is a clip, and an insulator is secured to this by a p and nut, as was formerly done in telephone work. From to the next pole which might be as much as 100 yards away, preferably not more than 60 or 70, a steel suspender of seven 14 gauge wires is run, and that is bolted up pretty tight. might say it is an extremely nasty job to the men making up e steel suspenders—turning the things around to make a good t wayleave job. Below this there was another similar insu- r and to this the cable was made fast. The cable ran right g below. Most of the main circuit cables were 19 No. 15 ge, the branches being about seven No. 16's, and so leading off even No. 20's, or something like that for a few lights. You see first of all that this steel suspender is absolutely insulated. t suspender will practically stand almost any voltage you could on it. The cable itself was insulated in the same way. posing it was a bare wire, there was always 3 inches of china ween it and the nearest earth. These cables were first of all ulated with little ebonite rings by which they were suspended, ing a little split ring which allowed them to run along the pender. Afterwards, Mr. Ferranti adopted raw hide-leather ngs which were slipped over the cable. The cable was all und up on a barrel or any convenient means. This cable was en up to the pole, the first ring put on, and the cart taken to next pole. If you are going to run half a mile of cable you uld have a man to almost every pole. They would haul the le, the men putting on the rings as it went by. Of course it is low process, but it is fairly satisfactory when it is done. First all you have the insulation of the cable; secondly, you have the ulation due to the raw hide thong; thirdly, you have the ulation due to the suspender, so that altogether you are fairly e. Supposing the suspender goes; the cable at first is bound und the insulator quite firmly enough. It is no good spending ot of money on insulation and getting tests in a test room, if u spoil it before it is up. But in this case these insulations re due to the cable that was wound around them and lapped ross so as to avoid as far as possible cracking the insulation in y way. Therefore, unless the pole came down bodily, there was t much chance of an accident happening, and if the pole came wn bodily, this insulation, as has proved to be the case in more an one instance, would be quite sufficient to keep everything ght until the fault was remedied. There is another advantage having this suspender. Our poles are usually lower than tele- one poles. The steel suspender the telephone people were at berty to draw their wires across as much as they liked. Occa- onally they would get a wire underneath, and when it was sagged ul it a few minutes, but they soon learned to leave off doing at. In fact, I have seen a coil of telephone wire with the little ittings, which, as you know, result from the arc. The second rcuit came under in the same way, and it was a point of good orkmanship amongst the linemen that the sag on the two wires hould be the same. I fancy people here do not bother their heads t all about that. In England if an employer saw one wire sagging nd another caught, the probability is that the foreman would be ismissed. Of course, working with the alternating current and n a parallel system we have no confusion of wires such as there s here. A single circuit was mainly sufficient for most of the re- uirements. In a few instances where lines were going into ifferent districts, owing to difficulties in getting our leaves, there ight be four wires but not more. I put it to American engineers hether this is not really the way of doing things. The number f circuits you get by running arc lamps or anything else in series ecomes in time stupendous, and I know in working in telephone ork underground, what a bother it is to be mixed up with con- uits, and the remedying of faults. In adopting a parallel system ou get rid of that and you get simplicity right away.

When we wanted to take the current off we put another of these rosses on and another set of insulators, and we took what we alled "T's" out of the cable at a few feet from the post. These f course were small wires; they were carried down the side of he house; the insulators standing well out from the wall, and as rule they went through the walls in china pipes, especially made or the purpose; that is to say, we do not simply take a chisel and un a hole through a wall anyhow and just put the wires through s I saw them doing in Pittsburgh. It was rather a costly job I must say. We finished up with Portland cement afterwards, the wire coming to a cut-out, which by the regulations of the fire insurance companies was either put on slate or on a brick wall. These wires were not allowed to be put on wood or near wood. Such things were not allowed as bringing a wire through the frame-work of a window. That would not be tolerated. When they come inside they come almost immediately to the cut-out and even if there happened to be a ceiling 3 feet above, the fire insurance companies insisted on large sheets of asbestos being fixed against that. From there we box our converters inside of iron bricks which were fixed in the wall, and on the way to the converter there was the usual switch for cutting the whole installation out. Of course this switch was very often not used at all by the householder. In fact it was more for the convenience of the central station people than for the householder. They turn off their lamps on the local circuits.

Now, before going further I would say something of a class of wire that was used. I think the reason that English work has taken the particular line it has, is almost entirely due probably to the fact mentioned by Mr. Lockwood that England has done all the cable work so far. We were accustomed to expensive wire for cable work, and consequently we did not kick when we had to pay £250 a mile for such a cable as 19 15's, which I dare say you would think a good deal here. The class of conductor we used was made of 19 No. 15's tinned on the outside. This was then wrapped around with three wrappings of fine rubber such as you use in making joints. Then on the top of that comes what is called a white rubber; that is wrapped on two or three times spirally; outside of that there is another of what is called black rubber. These two outside rubbers have vulcanised material mixed with them. When that cable is made to the thickness of insulation which we used on those cables and do use now—one-eighth of an inch of rubber—the cable is then put in the tank and vulcanised. Now, there is one point that cannot be too strongly insisted on, and which is this; that it is no use having an expensive cable like that if you are not going to protect it thoroughly. India-rubber will stand fairly well under water. It will stand fairly well in moist weather, but will not stand in dry air and it will not stand in alternations of wet and dry. If you will expose the rubber to the air it will in time perish. It is also liable, if it rests on anything sharp or sharply rounded, to get very thin at that point. It does to some extent flow away from the point and the insulation gets very thin. The way we went to work was this. On the outside of that cable is a fine water-proof tape which is vulcanised on to the material and absolutely forms part of it. How much further you go depends on circumstances, but a general rule was to take a compounded tape, that is, a strong linen tape twilled and dipped in some compound of ozokerit, and this was wrapped around in one or two cuttings. Outside of that we carefully put on a strong braid of yarn, and the whole was thoroughly saturated with the compound. You have then done about all you can do, and I may say that in London I believe there are three or four miles of cable of that class which has now been lying in iron pipes carrying a tension of 2,500 volts without any accidents. The cables are simply drawn into the iron pipes and lie side by side. I know that the Silvertown people four or five years ago laid down such cables as that for arc lighting throughout their works. The grounds at their works are fairly saturated with various mixtures, yet it has given them no trouble at all since. I cannot help thinking that if your cable is properly protected that it will not give trouble. That cable, of course, before it leaves the manufacturer is carefully tested. I have spent months in testing telephone and electric light cables of that character. This class of cable manufactured by the Silvertown Company would test from 2,000 to 8,000 megohms to the mile at a temperature of 75°. If you put the testing current on to a cable like that it flows into the cable with a great rush, and then the rush diminishes and you gradually see the spot of light coming back. One should always watch that spot of light for 10 minutes. Sometimes it will give a little kick, and that will denote that something is not quite right. But the Silvertown people have told me and I have known that they have manfactured in submarine cables as many as 70 miles of cable without locating any fault that they were obliged to cut out.

As to installation work, that is also done with first-class rubber covering thoroughly vulcanised. It usually depends a good deal on the fire insurance inspector. One man will pass one thing and another man will not pass it. You have got to know your man. Mr. Musgrave Heaphy first succeeded in imposing his rules more or less generally, and things now, I believe, are fairly up to his standard. His standard means that no wires are to be within an inch of each other in wood casing; that wood casing is used everywhere; that there are no exposed wires; that there are cut-outs to every two or three lamps; that the cut-outs have all slate or porcelain bases; that all switches have porcelain solid bases, and that no screws communicating with the current are allowed to come in contact with woodwork at all.

No doubt we have sacrificed rapidity of progress to some extent, and we have had a lot of trouble, still there has been immunity from accidents, which is very gratifying, and the work will stand. There is no doubt that the people when they put electric lights in their houses have an idea that it is going in just the same as gas fittings, but a good deal of electric work put in in past years I do not think would last as long as fair average plumbing. I am very much obliged to you for listening so appreciatively.

The CHAIRMAN: I would like to ask Mr. Addenbrooke his opinion on the proposition which we have heard considerable of within a few weeks, that while there is no particular difficulty in insulating a direct current of 3,000 or 4,000 volts, it is absolutely and entirely impossible by any known means of insulation to insulate an alternating current of a 1,000 volts. What is your experience as to that?

Mr. ADDENBROOKE: I think my experience was as fully and carefully stated—it is not a subject on which one likes to make a more or less random shot—but my experience was pretty fully stated in the ELECTRICAL REVIEW three or four years ago. I do not think there is anything whatever to show, in fact, I feel quite certain of this, that there is nothing to show that the alternating current will break down insulation quicker than a continuous current. I know a great many statements are made on the subject, but I do not know of any experiments which can be produced to that purpose. I do not know of anyone in England or America who has made a careful series of experiments on that point. We all know that the alternating current will not produce anything like the arc that the continuous current will. A continuous current of 1,000 volts will produce an arc—I would not like to say how much—longer than an alternating current will produce. We know that a cable doesn't receive the full charge of electricity, while you can see the movement of the galvanometer an hour after the cable has had the current on, but, of course, the great rush occurs immediately. Still it takes a very appreciable time, and in the case of an alternating current we will say, alternating 200 times a second, it is quite conceivable—I do not say that it is a fact, but it is worth putting forward that the insulating substance around that cable has not time to get sufficiently polarised to allow the discharge to pass through quickly before the current has turned in another direction, and has depolarised it. I do not say that that is a correct view. It is a thing that requires to be gone through very carefully. From all the observations I have seen and what I have heard on the question of insulation, I think that an alternating current will not go through more quickly than a continuous current.

The CHAIRMAN: The English telegraphic engineers have always taken the ground that a submarine cable was less injured by an alternating than by a continuous current. They have used the double current system on defective cables in preference to the single current system, which will tend to prove, I suppose, that they apprehended more trouble from the breaking down of the insulation by the continuous current than by the alternating.

At the close of the discussion Mr. Addenbrooke was thanked for the information he had laid before the meeting.

NEW PATENTS—1889.

16978. "Improved arrangement of conductors for electric series traction." J. M. M. Munro. Dated October 28.

17004. "Improvements in electric terminals and switches." H. I. Harris. Dated October 28. (*Complete.*)

17045. "The insulation of electric wires or cables." F. Morley. Dated October 29.

17075. "Applying electric current for heating rivets." P. Haden. (Communicated by H. H. Bales, East Indies.) Dated October 29.

17088. "Improvement in means for operating mechanical devices electrically." W. E. Irish. Dated October 29. (*Complete.*)

17124. "Improvements in interrupting devices for electric circuits, applicable for protecting electrical apparatus connected in such circuits." W. P. Thompson. (Communicated by the Westinghouse Electric Company, United States.) Dated October 29.

17142. "Improvements in electro-magnetic induction apparatus for transformers, generators, or motors." L. Bollmann. Dated October 29. (*Complete.*)

17115. "Improvements in electro-magnetic telegraph apparatus." F. X. Bachmann. Dated October 30.

17221. "Improvements in electric telephonic apparatus." H. L. Todd, W. F. Melbourne, J. Thompson and R. E. M. Mostyn. Dated October 30. (*Complete.*)

17260. "Improvements in holders for incandescent electric lamps." W. H. Oakley. Dated October 31.

17276. "An improved socket and adapter for electrical purposes." G. Donovan and W. Donovan. Dated October 31.

17317. "Improvements in electric measuring and regulating apparatus for use with alternate currents." W. T. Goolden and S. Evershed. Dated November 1.

17354. "Improvements in electric railways or tramways." L. Milne. Dated November 1.

17424. "Improvements in joints for armoured electric conductors." J. D. F. Andrews. Dated November 2.

17425. "Improvements in electric arc lamps. H. Harper. Dated November 2.

17484. "Electric shampooing and bathing apparatus." W. S. Frost. Dated November 4.

17511. "Improvements in devices for preventing the action of strong electric currents upon weak currents." C. Coerper. Dated November 4. (*Complete.*)

17521. "Improvements in the distribution and regulation of electric currents." W. Clark. (Communicated by S. Schuckert and Co., through Wirth & Co., Germany.) Dated November 4.

17581. "Improvements in apparatus for regulating and commutating electrical currents, applicable for use in dynamo-electric machines, motors, and meters." H. F. Joel. Dated November 5.

17611. "Improvements in electro-medical apparatus." C. B. Harness. Dated November 5.

17652. "Improvements in electric arc lamps." J. H. Rider. Dated November 6.

17675. "A new or improved apparatus for governing the electromotive force of dynamo-electric machines, driven by gas engines and other impulse engines." W. A. Higginbotham. Dated November 6.

17694. "An electrical watt meter." E. Wilson. Dated November 6.

17762. "Improvements in electrical switches." F. L. Rawson and W. White. Dated November 7.

17763. "Improvements in or applicable to electrical switchboards and switches." F. L. Rawson and W. White. Dated November 7.

17765. "Improvements in electro-magnetic dispatch apparatus or portelectrics." H. J. Haddan. (Communicated by J. T. Williams, United States.) Dated November 7. (*Complete.*)

17781. "An improvement in electric switches." W. White. Dated November 7. (*Complete.*)

17785. "Electric burglar alarm contact hinge." W. Smith. Dated November 8.

17793. "Improvements in galvanic batteries." G. J. Weir and A. Weir. Dated November 8.

17831. "Improvements in electric battery, carbon, and carbon compound elements and their connections." J. V. Sherrin. Dated November 8.

17915. "Improvements in the operation of telegraph circuits and in apparatus therefor." C. A. Gisborne. (Communicated by D. H. Keeley, Canada.) Dated November 9. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888

13687. "Improvements in and connected with electrical furnaces." R. E. B. Crompton. Dated September 22. 8d. Claims:—1. In electric furnaces the division of the operation of working the furnace into two parts, during the first of which the temperature of the contents of the furnace is raised to a desired degree by means of sources of heating other than that of the electric current itself. 2. In electric furnaces the combination of ignited heated gases introduced into the furnace by a series of burners or tuyeres, substantially as described, for the purpose of raising the temperature of the furnace to any desired degree previous to its operation by means of the electric current. 3. In electric furnaces the application of temporary nozzles for these jets made of material which will not injure the working of the furnace, substantially as described. 4. In electrical furnaces the arrangement of annular passages concentric with the carbon electrodes for the purpose of introducing the heating gases and for protecting the carbon electrodes, substantially as described. 5. The arrangements of the contents of electrical furnaces in such a manner that part of the charge may be ignited for the purpose of partially heating the contents previous to the introduction of the electric current.

15530. "Improvements in electric indicators." R. W. Paul. Dated October 29. 8d. Consists in shortening the magnetic circuit, reducing friction to a minimum, increasing the simplicity by the employment of one moving part only which acts as armature and indicating disc, while certainty of action is secured by the employment of a novel locking mechanism, of which the working is independent of gravity or friction. 8 claims.

CORRESPONDENCE.

Teachers and Students.

I have no desire to be drawn into that time-worn discussion as to who originated the compound interest principle of generating the magnetisation of dynamos. But as Mr. S. A. Varley in his long letter in your last issue has thought fit to drag in my name several times, and, as in each case he has coupled with my name some totally erroneous statement, I feel it necessary to set him and your readers right on these points.

First he says, "The Central Institution has involved the country to the extent of £300,000."

Now the total expense of building and equipping the Central Institution did not reach £300,000 or even half that sum; further, that Technical College, so far from having cost the country (that is, the taxpayers or ratepayers) one farthing to build, equip, or maintain, provides, on the payment of a remarkably small fee, a very complete technical education for any person, English or foreign, who likes to avail him or herself of it.

Secondly, he says, "These schools" (that is, the Finsbury Technical College and the Central Institution) "are presided over by Perry and Ayrton and Silvanus Thompson."

As Profs. Perry and Silvanus Thompson are at Finsbury, I presume, according to Mr. S. A. Varley, that I preside over the Central Institution. Now, the person who presides over the Central Institution is its Dean, nominated yearly by the Board of Professors from among their body; and the Dean for this year and for two years past is and has been Prof. Unwin.

Thirdly, Mr. S. A. Varley refers to some speech of his on a lightning bridge, made at a meeting of the Society of Telegraph Engineers, but which, he says, was omitted from the published Journal of the Society, and he implies that I, the Chairman of the Editing Committee, was responsible for this omission. As I have no recollection of the matter, I anticipate Mr. Varley will find that, at the time he speaks of, there was no Chairman of the Editing Committee, and that I had not returned from Japan.

Fourthly, he says: "A search made at the Patent Office in 1882 revealed the fact (previously unknown) that Soren Hjorth, &c."

Here, again, Mr. Varley is quite wrong as to facts. For in the Classified Abstracts of Patents on Dynamos and Electric Lamps up to 1878, that I made for the late Sir Francis Bolton, and which was communicated to the Society of Telegraph Engineers early in 1879, and occupied 66 pages of their Journal for that year, there is a section No. VI., headed, "Inducing Electro-Magnets Acted on by the Current produced by a Magneto-Electric Machine." This section (which, like the other sections, has its contents arranged in *chronological order*) commences with an *illustrated* abstract of Hjorth's patent, No. 2,198 of 1854, and the abstract ends with the following words in italics: "*This apparently includes the principle subsequently re-discovered by others.*" Next follows an abstract of Hjorth's patent, No. 806 of 1855, abstracts of two patents by Wilde, of the patent No. 3,394 of 1866 of Cornelius and Samuel A. Varley, an account of the communications made by Dr. Werner Siemens to the Academy of Sciences in Berlin in January, 1867, and by Dr. William Siemens and Sir Charles Wheatstone to the Royal Society in the following month, then an abstract of a patent of Siemens's, of another patent of Wilde's, of the patent No. 1,755, of 1867, of Cornelius and Samuel A. Varley, &c., &c.

To say then, as Mr. Varley now does, "that the Hjorth specification was brought to light through a systematic search of the patent records having been made in 1882 on behalf of Mr. Dredge," quite fails to represent the fact. Indeed, I may further add that, although the majority of electricians, on my showing them Hjorth's specification early in 1879, expressed great astonishment at its contents, one very well-known electrical engineer stated about that time that he knew of Hjorth's patent even before that date, and that the first thing he did in order to test the value of this classified abstracts of patents was to look whether I had found out Hjorth's specification, and appreciated its importance.

To attempt to undervalue Hjorth's patent appears to me as useless as it is ungenerous. His proposal to produce the field of a dynamo by electro-magnets and by permanent magnets, which "may be coiled like the electro-magnets," that is by a system of electro-magnets, the cores of some of which are of soft iron and of others of hard iron, and all excited by the current produced by the machine itself, closely resembles the plan adopted in the modern dynamo which has cast-iron frequently as part of the magnetic circuit, partly for mechanical reasons, and partly to produce steadiness in the action of the machine.

In all probability Hjorth was not aware in 1854 that if a dynamo be properly proportioned, and the iron employed in its construction be even all quite soft and unmagnetised, such a machine will, for a given speed and given resistance in the circuit, be in unstable equilibrium, and hence will excite itself. But were Messrs. Cornelius and Samuel A. Varley aware of this fact 12 years later; if so, why, in their patent of 3,394, of 1866, did they talk of starting the action by sending a current through the electro-magmets to produce an initial quantity of magnetism?

That part of Mr. S. A. Varley's letter that reflects on the moral character of technical professors is too undignified for me to stoop to reply to. Might I venture to suggest to him that, if in the past, he has been accustomed to use the intemperate language that characterises his present communication, it is not to be wondered at that he has, as he says, found it very difficult to make people believe in him or in his own identity. The genius of the Varley family stands prominently forth in the early history of electrical industry. But their fame will be dulled, not brightened, by this indiscriminate attack which Mr. S. A. Varley is now making on others, and which is based on statements as incorrect as they are unseemly.

W. E. Ayrton.

In the editorial comments on my letter which appeared in your last issue you say the Professors of the technical schools in connection with the City Guilds are not permitted to accept general retainers, "it being a *sine quâ non* that on their appointment they should give up commercial pursuits." This may be so *now*, but up to the time when the Central Institute was founded full-page advertisements in which Profs. Ayrton and Perry's names figured in connection with Telpher House regularly appeared, and they ceased at about this period. The general retainers would have been accepted before the establishment of the Central Institute, and if they were accepted at any time they practically hold good now; anyhow, if I have been doing the Professors presiding over the technical schools any injustice in the matter they can set it right at once by writing to the journal.

If the acceptance of general retainers has been stopped, patenting goes on now just as before.

When a company or a capitalist invests money in industrial works the managers and workmen whose services are paid for are expected to devote their whole services to the establishment, and so, also, the City Guilds when they established at the cost of some hundreds of thousands of pounds most perfectly fitted up scientific establishments, they naturally took it for granted that the Professors appointed at very liberal salaries would devote their whole services to furthering the cause of technical education, and we may be sure it never entered their minds to conceive they were fitting up laboratories to be largely used for the personal emolument of those appointed to preside over them.

What I complain of is that those having the chief control of the technical schools have been employing the influence and power conferred upon them to crush outsiders and to monopolise science as far as they are able by keeping its practical applications in their own hands.

I pointed out that, in a space of about six years, Messrs. Ayrton and Perry had applied for 16 patents, and that during about the same period Prof. Sylvanus Thompson had applied for 31, 12 of these, if my memory serves me, having been applied for during the year immediately succeeding his appointment to the position he now holds.

Now, if the time which must necessarily be given in working out and negotiating their respective patents, and the time occupied in writing and editing books be taken into consideration, to say nothing of the time occupied in preparing lectures on their patented inventions, as well as that which must have been consumed in advising and assisting business corporations, I would ask what individual attention to the pupils is possible.

S. Alfred Varley.

November 19*th*, 1889.

Continental Items.

Under the heading "Notes from Denmark and Norway," in your number for November 8th, there is some erroneous information about the Norwegian State Telegraphs.

The rates were reduced at the beginning of 1888; the number of inland messages for the first three quarters of this year was 664,957, against 571,685 in the same period of 1888 and the foreign ones, the received included, respectively, 373,629 and 353,224; the gross receipts were £59,000 against £52,000.

The three Scandinavian Kingdoms had in 1888 the following number of messages.

	Inland and Foreign.	Transit.	Total.
Denmark	1,099,724	425,544	1,525,268
Sweden	1,187,195	181,023	1,368,218
Norway	1,245,272	250	1,245,522

C. Neilsen.

Christiania, *November* 12*th*, 1889.

Electrical Trades Unions.

I am sure that many, like myself, were pleased to read the straightforward assurances of "Mr. Gooday" and "A Chairman of the Meeting" on the above subject, and I think that the former explanation is very clear; with regard to the latter, I did my best to give my reasons in the first letter, so I will not offer to intrude further on your space with more argument, feeling sure that others will see it in the same light as myself, that secrecy is of little use, and sincerely hoping that "a Chairman" may soon find some better opportunity to show his "knowledge of song" to better advantage.

Wallace J. L. Sandy.

Leeds, *November* 18*th*, 1889.

An Explanation.

My attention has been called to a paragraph appearing in your last issue. I am the Carl von Buch mentioned in the Bebro case, with which I have no connection whatever. It is true that I sold 500 shares in the Crystal Reef Company. Neither Mr. Harry Marks, with whom I am personally acquainted, nor myself can be held responsible for *ex parte* statements which have no other foundation than the fact above mentioned. I fail to see what bearing this has upon the Northfleet line or how it reflects on myself, and I must ask you to give as wide publicity to this letter as you have to the paragraph, which I can only conceive to have been sent you by someone wishing to injure either the syndicate or myself.

Carl von Buch.

November 11*th*, 1889.

Energy and Electricity.

Mr. Leonard Joseph, with delightful ingenuousness, states that he is "sure that there are but few who would, in the existing state of our knowledge, deny that force and energy are one and the same thing!" That is to say, in his view, there are few who would hold that the *dyne* and the *erg*, *g* and the foot-pound, the pull of a *kilogramme* and the *kilogrammetre*, the volt and the joule, are not absolutely identical. Could I possibly have found a better example of those writers who, from time to time, during the last quarter of a century, have mystified the young student, whilst wasting "editor's paper and reader's time" by vague and baseless dissertations on electrical questions which are altogether beyond their ken?

"But, sir," once said to me a very young man just beginning his studies, "nobody seems able to contradict them." "My dear boy," I replied, "when you have passed your preliminary exam. you will understand why nobody notices them, because *you* will then be in a position to contradict them."

Is it not curious that, in writing upon horticulture, a man is supposed to know the difference between a spade and a hoe, whereas, in writing upon electricity, a man may fill column after column without knowing the difference between force and potential work, electricity and electrical energy, or a watt and a joule?

The writers to whom I have referred are so encased in a pachydermatous envelope of the *double ignorance* referred to by Socrates that it is difficult to get *at them*. One method, however, which I have sometimes found efficacious is definitely to offer them a fair, and, indeed, a liberal price for *electrical energy* (watt-hours) provided they would make any offer whatever for the corresponding quantity of *force* or of *electricity*. The "settling up" when business has been done on these terms is something very funny.

My present object (which was my original object in writing) is not to insist upon any particular views as to the nature of electricity, but to be of some use to those who (not being satisfied as to the correctness of Clerk Maxwell's views—or never having heard of them) may desire to enter upon this question. My time is much occupied, and, Heaven knows, I have no desire to write unless I can, by writing, do some good. This being the case, would Mr. Leonard Joseph be very angry with me if I were to propound to him a few simple questions, the answers to which may be of curious interest to some, whilst contributing to the enlightenment of others?

(*a*). Has Mr. Leonard Joseph ever heard of a branch of exact science which was characterised by Maclaurin as the *Key to Nature*, and which is known as *Mechanical Dynamics?* Is he aware that the main object of this science is to investigate the relations between force and energy?

(*b*). Has he ever experimented with a common but beautiful apparatus known as Attwood's machine, improved by General Poncelet and by Morin, the object of which is the experimental investigation of the relations between force, mass and motion?

(*c*). By what process of reasoning would he establish the identity of $\frac{1}{15\cdot7}$th grain (1 dyne) with $\frac{1}{1\cdot356 \times 10}$ foot lb. (1 erg).

(*d*). On the whole, after due consideration and consultation with his friends, which statement would he consider the more difficult of disproof: (1) that force is a vegetable product or an allotropic form of carbonic anhydride, or (2) that force is energy.

(*e*). Would he consider the following a very "stiff" question for a youngster, in an examination to be passed before he was allowed to commence the study of electricity? "Give an equation (involving an accelerating force) for work or potential energy, and derive from it an equation for kinetic energy."

(*f*). Would he consider the following a satisfactory answer on the part of the youngster?

$$W = a\,m\,s \qquad \text{(I.)}$$

$$a = \frac{v}{t} \qquad \text{(II.)}$$

$$a\,m = f$$

$$W = f\,s \qquad \text{(Ia.)}$$

$$s = \frac{v}{2}\,t \qquad \text{(III.)}$$

(from II.)

$$t = \frac{v}{a}$$

(substituting this in III.)

$$s = \frac{v^2}{2\,a} \qquad \text{(IIIa.)}$$

whence

$$f\,s = m\,\frac{v^2}{2}. \qquad \text{Q.E.D.}$$

(*g*). Is aqueous vapour, *i.e.*, *steam*, a force, and, if so, is it therefore energy?

In conclusion, I have to explain that I had not the presumption to refer to Mr. Leonard Joseph when using the pronoun "we" in my last communication. I was speaking, as an electrician, to electricians.

Desmond G. FitzGerald,
M.I.E.E., M. Phys. S., Lond.

Railway Station Lighting.—A correspondent writes:—"I was exceedingly pleased the other evening to find when travelling by train that the Royal Oak and Westbourne Park Stations of the Metropolitan Railway were lighted by electricity. The lamps, which appeared to be of 16 C.P., were so placed as to give a good light on each platform, and the stations generally presented a striking contrast to those which are still lighted by gas. I hope this example will be followed at other stations. I remember, of course, that the underground station at Charing Cross was sometime ago partly lighted by glow lamps, but I do not think that such is the case now."

[redacted]